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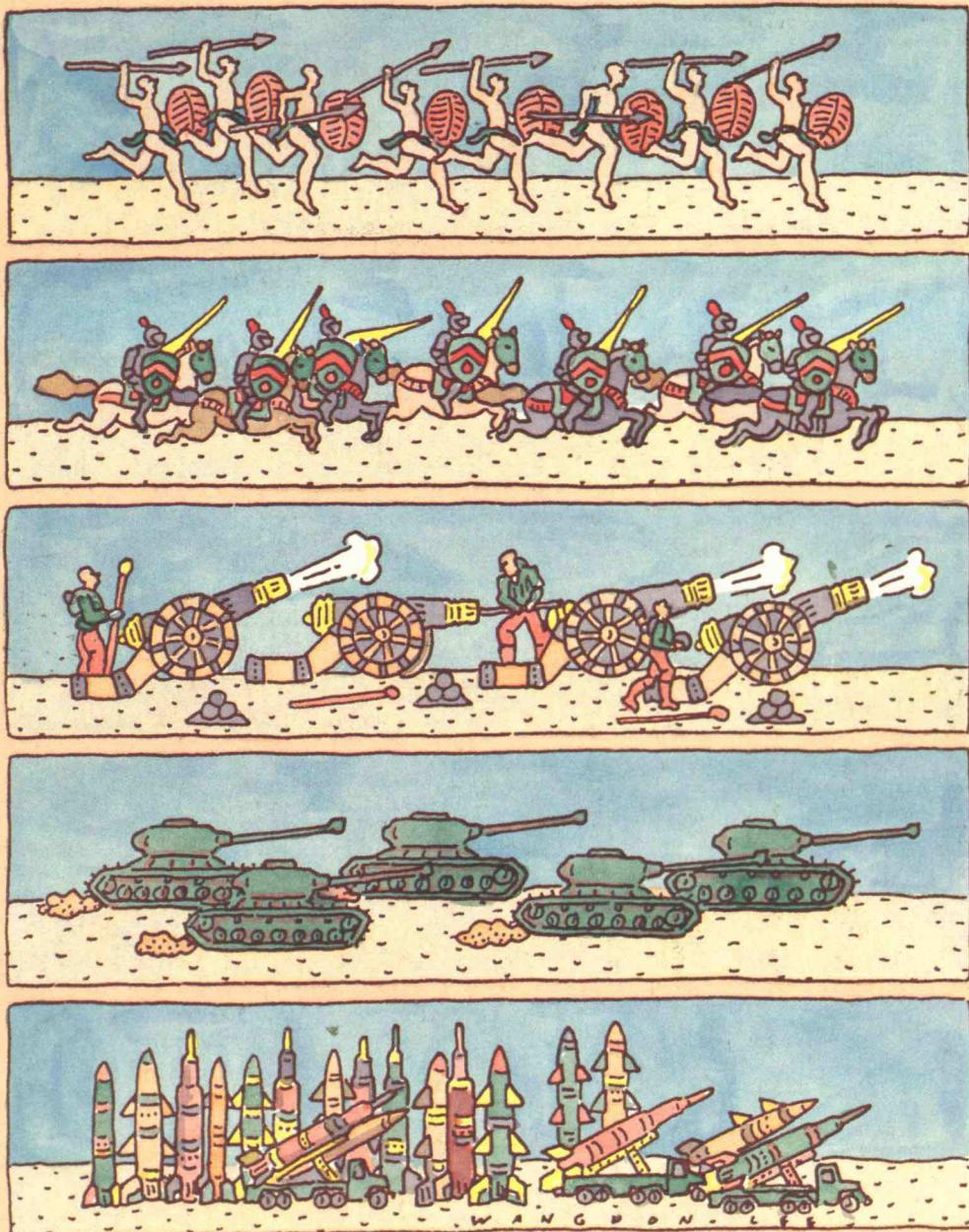
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Technology Review

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OCTOBER 1986

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AND TANKS

**TOMORROW'S
WEAPONS**

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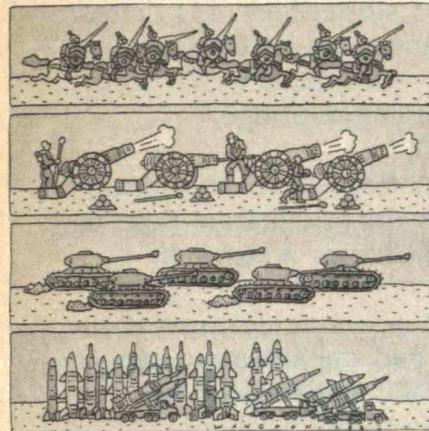
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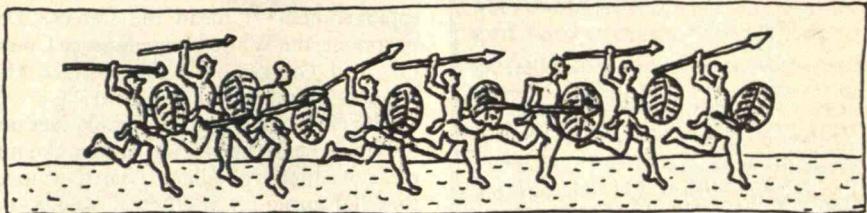
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Nuclear Obsolescence?



When most of us think of high technology applied to armaments, we think of ever more accurate missiles lofting ever more powerful weapons of nuclear destruction. It is a vision that confirms the worst expectations many of us hold for the role of new technology in modern warfare.

But high technology in fact may have a very different role in modern war. A first suggestion of this in the *Review* was made by Carolyn Meinel over four years ago. In "Trends" (February/March 1982, page 79), she reported how sophisticated missile-guidance systems were encouraging strategists to think of decreased reliance on nuclear warheads.

Four years later (May/June 1986, page 34), Michael Krepon, senior associate of the Carnegie Endowment for International Peace, described some of the new technologies that are improving the superpowers' ability to verify each other's adherence to arms-control treaties. "Advances in monitoring technologies . . . can do a great deal to restore public confidence in arms control," he wrote.

Finally, in this issue, we excerpt from

Frank Barnaby's forthcoming book, *The Automated Battlefield*, his argument that "smart" weapons are escalating the advantage of defense over offense. In the face of these new missiles, such monolithic manned weapons as warships, tanks, and aircraft are now extravagant, ineffective, and likely soon to be obsolete as weapons of war if not as symbols of power.

As a result, there is new interest in what Barnaby describes as a "nonprovocative," non-nuclear defense of the NATO countries. Smart weapons would be deployed to detect and destroy enemy forces on offensive missions in a 50-kilometer-wide zone between East and West. Their smarts would be so great and their effect so certain that they could replace tactical nuclear weapons for defense against an attack by Warsaw Pact forces. Thus at least one threat of nuclear war could be eliminated from the European environment.

Is it possible that technology can now justify a logic that the political process has thus far failed to accept—the limited usefulness, to the point of obsolescence, of the most destructive weapons that humanity has ever devised?—John Mattill

LETTERS

SDI AND IDEOLOGY

In reviewing Robert Jastrow's *How to Make Nuclear Weapons Obsolete* (April, page 78), Carolyn Meinel writes that I have decided that only 79 orbiting battle stations are needed to defend against 1,400 Soviet boosters. Though this estimate is close to that made by advocates of the Strategic Defense Initiative (SDI), it is unrepresentative of the paper from which it is excerpted. This paper provides many examples. No one has published any criticism of it, and the calculations have been endorsed by Edward Gerry, head of boost-phase systems for the Fletcher Committee of 1983. Also, ICBMs are here and now, and laser battle stations are of the twenty-first century. So it is unreasonable to expect laser battle stations to fight ger-

iatric Soviet SS-18s. Estimates that 1,000 battle stations will be required to kill 3,000 single-warhead fast-burn boosters must be taken seriously.

Meinel makes much of a supposed ideological battle in which Nobel laureate Hans Bethe and I are aligned against SDI proponents Gregory Canavan, a Los Alamos physicist, and Lowell Wood, a Lawrence Livermore Laboratory manager whom Meinel incorrectly identifies as part of the elite Jason group of defense analysts. However, both Bethe and I have long contributed technically to offensive and defensive weaponry. We simply feel that SDI is unworkable. Ideology has nothing to do with it. Furthermore, Reagan did indeed launch SDI without consulting the defense establishment. And by "defense

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LETTERS

CONTINUED

establishment" I mean the Defense Department, the White House Science Council, and George A. Keyworth II, the Reagan science advisor.

The fact is that Jastrow's book does not tell how the SDI program will "make nuclear weapons obsolete." Furthermore, the SDI program itself now makes no promise to do so. The program's goal is to strengthen deterrence not by defending society but "by defending the military across the board," according to Lt. Col. S.P. Worden, special assistant to the director of the SDI Organization. Worden says SDI will be successful if we can build a system that will allow the Soviet Union's nuclear-armed ballistic missiles to destroy no more than 2,000 military targets in the United States.

RICHARD L. GARWIN
Yorktown Heights, N.Y.

In her attack on us, Meinel misrepresents a narrow technical argument about the number of battle stations required to defend against Soviet boosters. This argument does not bear on the central issues, and it was settled almost two years ago anyway. She also claims that we "still hold powerful positions" and have "tried to use [our] influence to stifle debate." This assertion is too bizarre to warrant a rebuttal. SDI is backed by vast industrial and governmental resources, and it is ludicrous to posit that the case for the program has had difficulty gaining a fair public hearing.

We and our colleagues argue that SDI faces fundamental problems to which no solution is in sight. First, a comprehensive missile defense would have to rely on vital elements based in space, where they would be highly vulnerable. Second, missiles that survive boost phase would disgorge warheads hidden in a large swarm of decoys, and no combination of passive sensors could discriminate among them. Third, prodigious advances in many technologies would be required to build the defensive weapons proposed by SDI. Since a variety of highly effective countermeasures against those defenses are already known, the Soviets could respond to any of our advances by greatly expanding their offensive forces. Such an expansion would cost much less than the proposed American defense, and it would be much more reliable.

It is becoming clear that these concerns now worry many scientists who work on and support SDI. In March three members

of the Senate Appropriations Committee released an unclassified version of a detailed report on SDI. The report was based on extensive interviews held at the national weapons laboratories, and those interviews were arranged in collaboration with the SDI Organization. The central finding was that "the research being conducted by SDI clearly indicates that the technological hurdles are much greater, the possible Soviet offensive threat and countermeasures would be much more formidable, and the logistical and battle-management difficulties are much more complex than originally envisioned."

Meinel implies that we are ideologically biased, while SDI proponents are not. How, then, does she explain the opposition to SDI by former defense secretaries Harold Brown and James Schlesinger, the latter of whom is a member of the Committee on the Present Danger? And how does she account for the fact that one of the co-authors of our anti-SDI publications was Adm. Noel Gayler, who has served as commander-in-chief of all U.S. forces in the Pacific, director of the National Security Agency, assistant chief of naval operations for research and development, and deputy director of the joint strategic planning staff?

HANS A. BETHE

KURT GOTTFRIED

CARL SAGAN

Ithaca, N.Y.

HENRY W. KENDALL

VICTOR F. WEISSKOPF

Cambridge, Mass.

It is sad that Carolyn Meinel has not learned that there is no truly objective view of SDI. How can she expect anyone to take her review of Jastrow's book seriously when she openly declares that she is on the SDI payroll?

Her distress over Gregory Canavan's plight should be taken with a grain of salt as well. Having read some of his extraordinary "technical" memos, which advocate space-based systems to defend against theater nuclear weaponry in Europe, I am not at all surprised that his bosses have muzzled him.

FRAN BAGENAL
London, England

Carolyn Meinel's "book review" is little more than a tirade against the critics of the Strategic Defense Initiative. In the interest of fairness, it should be pointed out

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that Gregory Canavan has been silenced simply because his analysis is wrong. His predictions of the number of satellites required are valid only for a flat earth with satellites at zero altitude.

HERBERT LIN
Cambridge, Mass.

The author responds:

I apologize for misrepresenting Lowell Wood as a Jason. He has been a participant in Jason meetings, however.

Also, I happen to agree with Richard Garwin that space weapons aren't a good deal. But space weapons may not be needed for ballistic-missile defense. Fast-burn boosters or electromagnetic launch may make pop-up sensors and defensive weapons feasible. And I wholeheartedly agree that if all SDI does is strengthen deterrence, then we won't make nuclear weapons obsolete. Unless the program is coupled with a move to abolish nuclear weapons, we may wind up in deeper trouble than before.

When Hans Bethe and others raised technical objections to SDI, they trumpeted them in press conferences, a paperback book, and congressional hearings. When one of these same objections is shown to rest on erroneous calculations, it suddenly becomes "a narrow technical argument" that "does not bear on the central issues." The ideas that they outline in their letter are flawed, too: if you think missile defense is hard, so is missile offense. We have, for example, never successfully launched an ICBM from its silo, and our rockets like to blow up even on specialized launching pads.

Finally, I can't find in my article where I assert that only the anti-SDI position is influenced by ideology. My point was that all sides in the debate are politically motivated, which is one reason that it is hazardous to rely on of "experts." Moreover, people of several political flavors can oppose or support SDI.

As for the muzzling of Canavan, Herbert Lin is wrong to say that this action was justified. Canavan made one error among many correct calculations. If we muzzled every SDI researcher who ever made an error, the American public would be treated to dead silence. Bagenal's apparent endorsement of the muzzling is similarly bothersome. Freedom of speech is the most basic of our liberties. Abridgement of this freedom is another reason the experts cannot be trusted.



BATTLING FOREST PESTS

I share many of the concerns Michael Dover expresses in "Getting Off the Pesticide Treadmill" (November/December, page 53). We are currently experiencing record pest damage in our federal, state, and private forests, partly because some forest managers ignore the principles of integrated pest management (IPM).

One such principle is to promote basic good health in pests' potential hosts. But when economic pressures are intense, wooded areas inaccessible, and environmental laws extreme, it is difficult to uphold this principle. And, for that matter, to uphold a second principle of IPM: taking early action against pests that threaten to cause unacceptable damage. Early action can minimize losses, costs, and adverse environmental impacts. Also, pesticide use can often be avoided at the start of outbreaks, since many other control tactics are feasible then.

A third principle of IPM is to coordinate pest-management efforts among owners of adjacent lands. In forestry, this is often difficult because different landowners have different objectives. Those who manage their land to promote wildlife may be unconcerned about pests that affect trees. Consequently, they may be unwilling to invest in the insect-control strategies that could help preserve a nearby property managed for timber production.

I want to second Dover's comments on research. IPM research in forestry is inadequate given the extent of the pest problem, the cost of delayed control, and the environmental importance of forests.

JAMES L. STEWART
Washington, D.C.

Continued on page 24

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Summary:

GTE research in Artificial Intelligence has produced exciting results in several areas of knowledge-based systems. In addition, research is under way to teach computers to learn by themselves, much as humans do.

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2. How can we redirect traffic around the Denver congestion?



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formance, diagnose problems and recommend corrective actions in large communications networks.

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The nature of thought.

Another of our AI research directions is basic, long-range research into ways of teaching computers to learn for themselves, through experience and/or inference.

This involves research into such an area as the way children learn, as well as deep studies into the nature of decision-making itself.

Much remains to be discovered, of course—but the promise of true machine learning is perhaps the most exciting in the entire computer field.

The outcome of these projects—some near-term, some more in the future—will be to make the computer a far more useful and friendly tool for an immense variety of industrial and human problems.

The box lists some of the pertinent papers GTE personnel have published on various aspects of Artificial

Intelligence. For any of these, you are invited to write to GTE Marketing Services Center, Department AI, 70 Empire Drive, West Seneca, NY 14224. Or call 1-800-828-7280 (in New York State 1-800-462-1075).

Pertinent Papers

"COMPASS: An Expert System for Telephone Switch Maintenance," S.K. Goyal, D.S. Prerau, A.V. Lemmon, A.S. Gunderson and R.E. Reinke, Expert Systems: The International Journal of Knowledge Engineering, Vol. 2, No. 3, August 1985, pp 112-126.

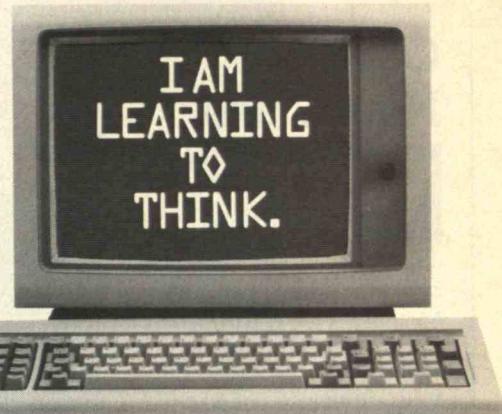
"Selection of an Appropriate Domain for an Expert System," D.S. Prerau, AI Magazine, Vol. 4, No. 2, Summer 1985; pp 26-30.

"A Natural Language Interface for Medical Information Retrieval," G. Jakobson, C. LaFond, E. Nyberg and V. Shaked. Third AASMI Joint National Congress on Computer Applications in Medicine, May 1984, San Francisco, California. pp 405-409.

Computer Experience and Cognitive Development, R.W. Lawler. Ellis Horwood Limited, Chichester, U.K. (1985). (Summary of book.)

"The Learning of World Models by Connectionist Networks," R.S. Sutton and B. Pinette. Proceedings of the Seventh Annual Conference on Cognitive Science Society, 54 (August 1985).

"Training and Tracking in Robotics," O.G. Selfridge, R.S. Sutton, A.G. Barto. Proceedings of the Ninth International Joint Conference on Artificial Intelligence, 670 (August 1985).



The Jivaro of Brazil gave modern medicine quinine, and the tribe may have more to offer. Moist bark from these branches reduces swelling.

Old Lore, New Cure

When Walter H. Lewis saw the Vicks VapoRub bottle in the remote Amazon community, he knew it was a bad sign. Lewis, a senior botanist at Washington University in St. Louis, Mo., had traveled to Peru to study medicinal plants used by the Jivaro, a tribe that knows little about other civilizations. He is concerned that as such peoples adapt to industrial society, knowledge of the medical uses of thousands of plants could die out. Some of this knowledge could be invaluable to modern medicine.

Lewis and his wife, Memory Elvin-Lewis, plan to take up to six trips to Peru and Ecuador during a three-year project. They have completed two of the trips already. They chose to study medicinal plants used by the Jivaro because of the tribe's track record: it has taught the world about quinine, which is a treatment for malaria, and curare, which industrialized nations use as an anesthetic and a muscle relaxant.

The Washington University team is not the only group to take an interest in what is known as medical ethnobotany. U.S. pharmaceutical companies have begun to pay some attention recently, says Ghillian Prance, senior vice-president for science at the New York Botanical Garden. That's a switch: until recently, drug manufacturers were so enamored of synthetic chemicals that they avoided investigating natural remedies, he says. Prance believes that the rekindled interest of pharmaceutical companies relates partly to some plants that ethnobotan-



ists have already brought into the country. He believes it also relates partly to the companies' worries that their Japanese counterparts might be funding botanical expeditions to remote parts of the world.

The Amazon attracts many U.S. researchers because of its enormous genetic diversity. Lewis, who directs the herbarium at Washington University's Missouri Botanical Garden, adds that Western botanists are more familiar with New World species than with those from elsewhere.

After spending three months in Peru in the past year, the Lewis expedition has collected more than a thousand species. Lewis says he is fascinated that the Jivaro, who do not have a written language, could use such a wide diversity of plants and remember the names of each. From snakebite to kidney ailments, "They have something for every kind of illness you could imagine that's down there."

Accompanied by an Italian linguist who speaks Jivaro dialects, Lewis and Elvin-Lewis gathered much of their information from village *curaderos*. These are typically older community members, often grandmothers, who treat medical problems. Lewis says that in the past ethnobotanists have looked primarily at plants affecting the mind, learning about them from witch doctors, who perform many of the same functions as psychiatrists.

The Washington University researchers believe it is particularly helpful that their team includes a woman. Jivaro women do not speak freely to strange men, and it is the women who generally administer medicines to children or to anyone with urogenital problems. From women *curaderos* Elvin-Lewis learned about such medicines as a plant extract that is said to make women fertile.

Elvin-Lewis, who is a den-

tal microbiologist, also learned about a tree in the mulberry family whose latex the Jivaro apply to teeth they wish to extract. The teeth crumble and fall out painlessly within 10 days. The team thinks this could be useful for older people because it is less traumatic and bloody than pulling out teeth. Additionally, the Jivaro taught Elvin-Lewis about two plants they chew to blacken their teeth. She believes that chewing these plants probably prevents cavities. The idea was reinforced when she visited a community in which few Jivaro blacken their teeth. This group, which has adopted some of the ways of outsiders, has far more cavities.

Lewis says that the Jivaro could soon face a host of similar problems because they are beginning to be influenced by oil-company workers who are drilling relatively close to their communities. As the tribe acquires Vapo Rub and other "magic" medicines,



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they might lose their knowledge of local medicinal plants. When the oil dries up and the outsiders leave, the Jivaro will be left without this vital information.

One of the most unusual plants the team has learned about supposedly heals broken bones. Called *supaychac* by the Jivaro, the plant appears to have a Vitamin D analogue in its leaves. The researchers don't yet know if *supaychac* lives up to its reputation, but Vitamin D is known to spread calcium, which promotes bone mending, from the gastro-intestinal tract throughout the body.

The researchers also learned about a plant the Jivaro use to prevent pregnancy for three months. Lewis thinks contraceptives that work for such a long time could be especially useful in Third World countries. He says many people find it hard to understand that they must take oral contraceptives daily.

In 1975, information about

another possible natural contraceptive was brought to light by a team from the New York Botanical Garden's Institute of Economic Botany. The team, headed by Prance, learned about a plant the Deni tribe uses in Brazil. Drinking a mixture of water and juices from the vine of this plant is said to prevent pregnancy for two years. Drug manufacturers originally showed little interest, but now several companies have approached the group, Prance notes.

Urúchnumi, a plant collected on a Lewis expedition, has also attracted the interest of a drug company. *Urúchnumi* stops bleeding almost instantly when applied to the skin, and scars seem to disappear within two days. The Jivaro use it for bleeding gums, too, and Lewis learned of a Peruvian doctor who has given it for ulcers. Monsanto has started informal lab investigations on the plant, Lewis says.—Laura van Dam



Safety for Seniors

The walk light flashes to green. An elderly woman starts across the street, but "don't walk" starts flashing when she is halfway. She panics and turns around in confusion. Drivers become angry.

The speed limit is 55 miles an hour, but the elderly man in the right lane is going only 45. As other drivers rush by, they honk their horns and mutter that old people should keep off public highways.

Sixty bus passengers fume as one 80-year-old woman takes three minutes to climb on. The driver jerks the bus forward. She falls and breaks her hip, ending up dependent

on others for several months.

These are examples of blaming elderly people for their inability to cope with transportation systems that are, says Joregen Christensen, "designed for the young and the able and the rich." He chaired an international panel of experts that looked into ways to improve safety for elderly road users. The project, begun in 1983, was run by the Organisation for Economic Co-operation and Development (OECD) and the World Health Organisation (WHO). The panel has recently issued guidelines aimed "particularly at local road-safety officials and engineers—those with a practical responsibil-

ity," says Christensen.

He points out that "we are disregarding the particular mental and physical deficiencies that all of us will experience." Complicated intersections, highways with high speed limits, crosswalks with short green-light sequences, and many other factors contribute to the high rate of accidents and injuries the elderly suffer. For the same amount of driving, people over 65 face a risk of dying at the wheel two to five times higher than people 25 to 64. When traffic accidents result in injuries, the elderly victim is about three times more likely to die from them later on.

The report warns against the easy solution of imposing restrictions. This would not solve the transportation needs of the elderly, and could make matters worse: "Restrictions on elderly drivers could push them into inactivity and withdrawal to the detriment of their general health and well-being."

In any case, restrictions would be highly sensitive politically since for the elderly, as for everyone else, transportation is a necessity. "Elderly people still depend on their cars just as younger people do," says John Fegan, research psychologist for the U.S. Federal Highway Administration and a mem-

Excellent and respected nurses do more than technology to ensure that intensive-care patients will recover.

ber of the OECD/WHO panel. He notes that three out of four people over 80 walk without assistance. "I don't think the elderly are as decrepit as people think they are."

As a rule, older people use transportation less. The average distance people over 65 travel annually is only 30-40 percent of that younger people travel. But the elderly are twice as likely to walk, and when they do, they suffer five to seven times as many fatalities as younger people walking. One reason for this is that they spend more time exposed while crossing. In addition, it is more difficult for them to move out of the way of danger.

"Prolonged reaction time and reduced physical capabilities of the elderly as well as the problem many of them have making a decision in a difficult situation are being disregarded," says Christensen. As the report notes, "the 'cumulative handicap' can be quite significant."

Where available, public transportation would seem part of an obvious solution for elderly people who cannot drive. Official statistics indicate that public transportation is relatively safe. However, most accidents on buses and subways are probably not reported as traffic accidents. For example, problems with balancing make elderly passengers very prone to falls when boarding or getting off a bus or while the bus is moving. One result may be that older people give up using public buses.

The bus also illustrates how easy it may be to adapt transportation to the elderly. Falls could be reduced by making the bus entrance closer to curb height and by providing more handholds inside.

Those who design transportation must more carefully consider the capacity of all people—old and young—to gather information, make judgments, move, and adapt to new situations. The reduced ability of the elderly to handle complex traffic patterns, such as turn-only lanes, could be compensated for by "larger lettering on highway signs and simpler graphics," says Fegan. "The elderly recognize symbols just as well as young people do. They simply take longer to process the information."

Other improvements might include lower speed limits, pedestrian refuges, and traffic-signal phases during which all vehicles stop while pedestrians cross the street. Overpasses or underpasses at particularly busy intersections help pedestrians, but only if they are convenient and not too steep.

Cars could be designed to aid the elderly. "At the very least," says the report, vehicle design "should not constitute an additional handicap." Power controls, variable pedal and seat heights, and mirrors adjustable from the inside are available, but they are usually expensive options. Making them affordable to the elderly is crucial. However, both vehicles and advertising are usually designed for young customers.

Christensen stresses that "helping the elderly road user will in most cases improve the conditions for others as well." A case in point is public transportation: in the United States, older people are reluctant to use it partly because of uncomfortable rides and inconvenient schedules. "The elderly," says Christensen, "present a particularly vulnerable group of road users and accentuate the problems for all." —Marc Miller

Nursing Beats Technology

Whether a patient in intensive care lives or dies may depend more on the interaction between nurses and doctors than on specialized treatment. William A. Knaus and his colleagues at George Washington University Medical Center in Washington, D.C., studied 5,000 patients in intensive-care units (ICUs) at 13 large hospitals, each of which had 300 to 500 beds. The team discovered that a unit's administrative structure, technological capability, and staffing patterns did not seem to affect the patients' health.

Knaus, who is director of the Medical Center's Intensive Care Research Unit,

points out that patients appeared to fare much better when coordination between physicians and the nursing staff was high. Since it is now possible to measure physiologic factors that affect the risk of death from severe illness, "the influence of other variables in the actual care process becomes more apparent," he says.

To evaluate the care provided by a particular ICU, Knaus and his group developed a sophisticated system, which classifies diseases according to their severity, called the Acute Physiology and Chronic Health Evaluation (APACHE). In a number of studies in the United States and Europe, the system has consistently demonstrated a strong, stable relationship between its measures of illness severity and the probability a patient will die. Finland and Denmark have adopted APACHE as the official means



Patients in the intensive care unit are often at risk for serious complications. One of the most common is a bacterial infection.

of auditing ICU performance. In the United Kingdom, the Intensive Care Society, which is responsible for periodically auditing ICUs, will be using the system soon.

Knaus and his team compared APACHE predictions with the actual number of people who died in each hospital's ICU. They found some surprises. Institutions apparently very similar to one another in the operation of their ICUs differed markedly in the variance between the APACHE predictions and the actual number of deaths. These differences held within specific diagnostic categories, for medical patients alone, and for medical and surgical patients combined.

At the institution with the fewest ICU deaths in comparison to the APACHE prediction, the nursing staff had a great deal of independence within carefully worked-out medical guidelines. This hospital experienced 30 deaths in its intensive-care unit. APACHE had predicted 46.

Communication between the physicians and the nursing staff at this hospital was excellent. A high-quality educational program was targeted both to staff nurses as care-givers and to charge nurses as managers. Confident and respected, the intensive-care nurses at this hospital even had the authority to postpone a surgery if they felt there was not enough nursing staff to provide adequate post-operative care. "A hospital system like that recognizes that nursing is the most important aspect of intensive care," Knaus observes.

The contrast between the hospitals that ranked third and last in performance was especially revealing. These two hospitals were remarkably similar in the amount and type of treatment they gave

patients. Both were non-teaching, community institutions that lack established medical guidelines for care. Neither had a full-time ICU director or physician staff member to direct a policy for decisions about admissions, discharges, or treatment.

The difference was in the hospitals' approach to their

nursing staff. At the third-ranked hospital, doctors accompanied the charge nurse and each patient's primary care nurse on daily rounds of patients. Together they set immediate and long-term goals for the patients. In addition, nurses could reach physicians during the day for frequent consultations.

"Nurses could make suggestions about a patient's care to the doctors," says Knaus. "Their suggestions were acknowledged and often followed." The ICU also had a centralized, nursing authority, low staff turnover, strong support by supervisors, and a formal educational program. At this hospital, 20 people

MINITRENDS

LIGHT CURE:

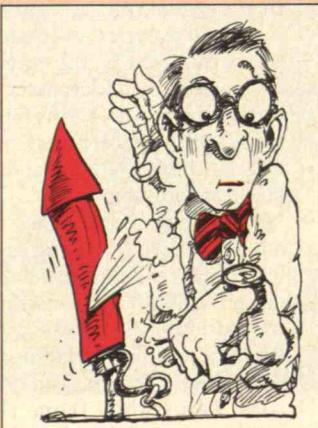
Researchers at the University of Minnesota have employed ultraviolet light to treat a site contaminated with polychlorinated biphenyls (PCBs), highly toxic substances formerly used in electrical equipment. While laboratory experiments have shown that such photochemical treatment is feasible, this was the first trial in the field. An on-site photochemical treatment could be especially valuable in cleaning up buildings.

Ultraviolet light strips chlorine atoms from the PCB. William Draper of the University of Minnesota's School of Public Health points out that "the less chlorinated PCB constituents are also the least toxic. Furthermore, constituent molecules with the least amount of chlorine are most readily biodegraded in nature."

The scientists irradiated a PCB-contaminated site at the University of Minnesota's research facility in Rosemount for 21 hours. Before irradiation, the PCB concentration was 81 micrograms per 100 square centimeters. After the treatment, the concentration was 43 micrograms per 100 square centimeters, a reduction of 47 percent.

The next steps will be to increase the intensity of the ultraviolet light, pre-treat the surfaces with chemicals to enhance the effect of irradiation, and test the procedure

on chlorinated dioxins. These chemicals are produced when PCBs are burned. They are even more dangerous than PCBs themselves.



SLOWER SOUND:

It's time to rewrite textbooks and redo formulas. Canadian scientist George S.K. Wong has recalculated the speed of sound. It's 741.1 miles per hour. For decades, scientists have said it was 741.5 miles per hour. In surveying the literature on sound measurement, Wong noted that the last calculation was made in 1942.

NATURAL PRESERVE:
Researchers at Rutgers University have found a way to preserve food naturally using extracts of the common spice rosemary.

While the preservative power of spices has been well known for centuries, their

strong flavors have prevented their being used widely. "You wouldn't want to eat rosemary-flavored corn flakes," observes Steven Chang, who directed the research. The Rutgers team analyzed rosemary to determine what chemicals in it cause the antioxidant activity that is responsible for the effectiveness of most additives, including BHT and BHA. The researchers extracted the antioxidant compounds and distilled away the rosemary smell and taste.

Chang says that "the activity of our extract is equal to or better than BHT, which is the best synthetic antioxidant." The food industry is enthusiastic about the research, and a number of companies have contacted him.

DATABASE DATA:

By 1985 3,010 databases were available to the public, up from 301 in 1976. The number of records contained in databases had risen from 52 million to almost 2 billion. This explosion is documented in *Computer-Readable Databases: A Directory and Data Source Book* by Martha Williams of the University of Illinois at Urbana-Champaign.

Her research also shows that 57 percent of today's databases are privately operated, although in 1976 most databases were government operations. Of all databases,

died in the ICU, near the APACHE prediction of 23.

At the bottom-ranked hospital, 38 people died in intensive care, compared to a predicted 21. Here, the ICU's nursing leadership changed frequently. The hospital had no regular education program for its nurses. Nor did it have any provision for having the

same nurses consistently care for the same patients or for discussion between doctors and nurses about a patient's treatment. Moreover, the number of nurses on duty was not coordinated with the amount of care needed. Knaus noted frequent disagreements between doctors and nurses about whether the

nursing staff could treat additional patients.

The lines of communication between doctors and nurses were "very, very poor," Knaus says. "When we visited the unit to enroll it in the study, the physicians and the nurses refused to sit in the same room."

—Suzanne Wymelenberg

36 percent contain numerical information, 36 percent contain bibliographic data, and 18 percent store the full text of documents. Finally, 10 percent are directories, including "The Database of Databases," the electronic version of Williams' book.

FROZEN ENZYMES:

Enzymes are catalysts produced by living cells. They initiate or speed the rate of chemical reactions, but normally they lose all their activity when they are frozen. In research sponsored by the National Science Foundation, Steven Hand and John Carpenter of the University of Southwestern Louisiana have found a way to protect enzymes susceptible to freezing. The enzymes are dissolved in a sugar solution containing a small amount of zinc. Almost any sugar can be used, and since the sugars and zinc are not toxic, the thawed solution can be used without further processing.

The biologists made the discovery while studying brine shrimp, which are capable of "cryptobiosis." That is, they can be frozen or completely dried without permanent effects. Dehydrated brine shrimp can be rehydrated just by adding water. "It was the ability of brine shrimp to survive such treatment, especially freezing, that led to our discovery," says Hand. The findings may be of

great value to the drug industry because freezing could extend the shelflife of enzymes indefinitely.



FISH TALK:

Although fish don't talk, they do have a complex auditory system. Peter Rogers, a mechanical engineer at Georgia Institute of Technology, suggests that fish are listening to random sounds emitted by one another's swim bladders. The swim bladder is the organ that fish use to maintain their buoyancy. They use the sounds to "see" their neighbors, much as most animals see objects by perceiving the random light scattered off them.

Rogers says that by monitoring swim-bladder sounds, "the fish could detect the presence and bearing of another fish." The researchers calculate that a medium-sized fish could perceive other fish several feet away.

ENERGY AUCTION:

In June, the U.S. Department of Energy acquired legal title to the nation's largest synthetic-fuel facility, the Great Plains Coal Gasification Plant north of Beulah, N. Dak. The department was the only bidder in the court-ordered sale of the facility, which had defaulted on more than \$1.5 billion in federal construction loans.

The sale of the plant marked the passing of the 1970s concern about self-sufficiency in energy. The plant, America's first commercial-scale facility to produce synthetic natural gas from coal, was built between 1981 and 1984, when energy prices were projected to continue rising. The original partners, the Great Plains Gasification Associates, had secured the construction loans through the Department of Energy, and they had planned to repay those loans to the government with the revenue expected to be generated over the facility's projected 20-year lifetime.

The government began operating the facility in August 1985. Since then, according to Energy Secretary John Herrington, "not a single dime of additional public funds has gone into plant operations." Next the department will try to find an investment firm to help it sell the plant and thus recoup some of the \$1.5 billion loss.

Currents and Climate

When TOPEX/POSEIDON streaks into orbit aboard a French Ariane rocket, it will begin a long-term comprehensive observation of the circulation of the world's oceans. The project is expected to provide a detailed insight into ocean dynamics and lead to the first accurate models of ocean circulation. One result could be safer, more economical navigation. Even more important, in combination with information gained from other satellites and from experiments on earth, TOPEX/POSEIDON will greatly improve our knowledge of the world's climate.

The mission is a joint effort of NASA's Topography of Ocean Experiment (TOPEX) and the French Space Agency's POSEIDON. It is currently scheduled for 1991, although cuts to NASA's funding could cause a delay. If everything goes according to plan, the launch will coincide with an international investigation of surface and sub-surface ocean phenomena. This worldwide project, the World Climate Research Program, is being conducted under the auspices of the United Nations' World Meteorological Organization and the International Council of Scientific Unions.

Navigation along coastal areas depends upon accurate knowledge of tides, tidal currents, and surface winds. But in many areas navigators still rely upon incomplete tidal forecasts collected with shore-based gauges. And for at least a century, data collection at sea has not changed

significantly. Ships move to fixed "hydrographic stations." At each station devices which measure water properties from the ocean's surface to its bottom are lowered into the water on cables. This yields general circulation maps showing average arrangements of water masses. Another problem is that observations were made over many decades, although maps of ocean currents probably change from month to month. In addition, great expanses of oceans and seas do not have any high-quality hydrographic station.

In 1978 NASA launched SEASAT to observe the oceans. It failed unexpectedly after only 104 days, but its short-term measurements showed that radar from a satellite could measure global ocean circulation in detail by measuring the height of the ocean. TOPEX/POSEIDON is expected to function for three to five years, and its radar will measure sea height within one inch. This precision is important in developing accurate maps of currents, particularly mapping the distribution of permanent ocean currents.

The principal instrument aboard TOPEX/POSEIDON is a radar altimeter that sends short pulses of energy toward the ocean surface. These signals are bounced back and captured by the altimeter antenna. By noting the time required for the round trip and the intensity and structure of consecutive returned signals, it is possible to determine the elevation of the sea surface, the height of its waves, and the speed of wind by observing its effect on the surface.

Robert Stewart, the project scientist for TOPEX/POSEIDON at NASA's Jet Propulsion Laboratory in Pasadena, Calif., suggests that the satellite will aid navigation by providing "maps of the ocean currents and present wave conditions." Although hydrographic maps would continue to be published, the maps generated by TOPEX/POSEIDON would provide up-to-date information and greater accuracy. These would be the only maps for regions that lack high-quality hydrographic stations.

The TOPEX/POSEIDON oceanographic data will be combined with data from the

U.S. Navy's Remote Ocean Sensing System satellite (NROSS). Stewart says this will help meteorologists construct wind maps. And since wind distributes solar heat from the tropics into polar regions, better knowledge of worldwide climate trends is expected to result. So far, our knowledge about ocean wind has come primarily from information collected by ships, and has been confined to well-traveled sea routes. Consequently, no regular data has been available to calculate seasonal variations.

Though TOPEX/POSEIDON will detect wind speed, it will not detect wind direction. However, Stewart says NROSS's wind scatterometer will determine both. Because wind is the chief factor influencing waves and currents, merging the NROSS wind data with that of TOPEX/POSEIDON could help build wave forecast maps, and it will lead to a better understanding of wind-driven currents.

Scientists also hope TOPEX/POSEIDON will teach them more about mesoscale eddies, a class of phenomena discovered recently. As storms are

important to meteorology, eddies are important to oceanography. The highs and lows of these localized "storms" continually build up and dissipate across the ocean surface.

Eddies contribute to large currents, and, along with currents, they move the bulk of the earth's absorbed solar energy. TOPEX/POSEIDON measurements of the ocean's surface, plus data from other projects in the World Climate Research Program, should provide the first reliable measurements of how much energy the world's water is moving. This will be key to understanding worldwide climate trends.

—Janette Hickman

TecNICA

Besides being devastated by a 1972 earthquake, a revolution, and a guerilla war, Nicaragua suffers from a dilemma endemic to the developing world: a shortage of talented technicians. Enter TecNICA, an organization founded in Berkeley, Calif., in 1983 to match North American volunteer technicians to the country's needs.

In less than three years, TecNICA has sent more than 200 volunteers to Nicaragua. All have paid for their own travel, room, and board for a two-week stay. TecNICA volunteers have contributed more than \$2 million worth of technical assistance, says Michael Urmann, an economist who taught at the University of Utah for eight years. He founded TecNICA after attending a conference on Third World economic development in Nicaragua's capital city of Managua. Now he



SEASAT took this picture of the ocean's surface in 1978. That mission proved the value of satellites for oceanography.

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TecNICA volunteers alleviate Nicaragua's shortage of technicians. Many repair equipment in facilities such as this hydroelectric plant.

works full-time running the organization.

In the last year, TecNICA has sent 10 delegations of computer experts, electrical engineers, chemists, and architects to Nicaragua. About 15 percent of volunteers go on their own if they can't get away from their jobs during scheduled TecNICA projects. With an average age of 39 and an average income of \$35,000, these people don't fit the typical image of North Americans who volunteer to work in the Third World.

"We're talking about people who are already pretty well set in their careers," says Lou Proyect, a systems analyst working with Goldman Sachs in New York. He is TecNICA's East Coast coordinator. "These are people who are looking for a way to express their political beliefs. Generally, they're delighted to find they can make a difference."

Because hard currency is scarce, Nicaragua holds onto computers that have long been considered outmoded in the United States. Many computers were purchased from North American companies in the 1970s. Proyect spends

a good deal of time looking for technicians with experience on the IBM-34 series computer from the late 1970s—a model common in Nicaraguan banks and agencies. "It's like fishing," he jokes, explaining that in 1985 he took his "net" to an IBM-34 users' fair in Louisville, Ky., where he conducted a seminar on Third World development and the computer. In his audience he found two of the five IBM-34 technicians TecNICA would send to Nicaragua later that year.

Volunteers work mainly with development agencies and non-governmental bodies such as universities. Gary Benenson, an electrical engineer from Brooklyn, N.Y., spent two weeks in Managua in May 1985. He taught 20 workers at a government agency basic equipment maintenance. "I was able to explain what a UART does or what op-amp does. I also gave them a bare-bones view of microprocessors," he says. Later, when another group of TecNICA volunteers went to the same agency, workers got a refresher course.

In September 1985, TecNICA volunteer Ed Geller

taught graduate-level seminars in fluid dynamics at the National Engineering University. He also advised on the design of a hydroturbine and the design of a power plant that would use low heat. On the same trip, Dennis Stout worked at the Ministry of Health on the mundane but essential task of repairing the large laundry machinery in Managua hospitals.

Other TecNICA volunteers soften the impact of the U.S. trade embargo of Nicaragua by repairing damaged equipment and stretching existing supplies. "Our expertise keeps the old models working," says Proyect. He adds that it keeps U.S. technology operating in the country should more peaceful relations resume.

Though TecNICA acts counter to the U.S. government's official Central America policy, it has not broken any law. Nor has it violated the U.S. economic embargo. The volunteers are not involved in commerce, and the aid they provide is considered humanitarian.

Thus, while disapproving of TecNICA, the U.S. government doesn't interfere with it.

Says Greg Lagana, a State Department spokesman. "All of these projects are seen by people as support for the [Sandinista] government. But they're free citizens. They can do whatever they want."

Nevertheless, TecNICA is sometimes caught in the middle of the quasi-war between the United States and Nicaragua. John Leek, a TecNICA volunteer from Boston University, spent January along the Nicaragua-Honduras border helping to repair a hydroelectric generating station. Since the station had been damaged by U.S.-backed contras, he was working against U.S. policy. However, most TecNICA volunteers work in Managua rather than in war zones, so most face little physical risk.

Urmann says TecNICA helps Nicaraguans see a difference between ordinary Americans and the policies of the U.S. government. He says, "We're basically working with our peer group—middle-class professionals. It helps keep their morale up."

Like the Peace Corps, TecNICA hopes to expand to other developing countries. And as with Peace Corps volunteers, those who go to Nicaragua with TecNICA may find that what they receive is as valuable as what they give. "In a sense TecNICA made me a better technician," says Benenson, who also teaches electrical engineering at the City University of New York. "More than half of my students are from other parts of the world, many from the Caribbean and Latin America. Working in Nicaragua gave me insight into their problems adjusting to life in another culture. It also taught me there is something I can do to help other people. Now I'm looking for new ways."

—Joel Millman

"We are made wise not by the recollections of our past but by the responsibility for our future!"

—George Bernard Shaw

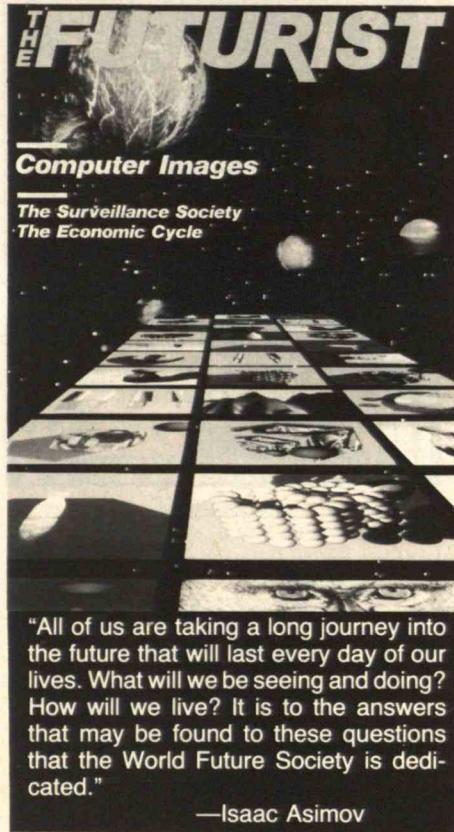
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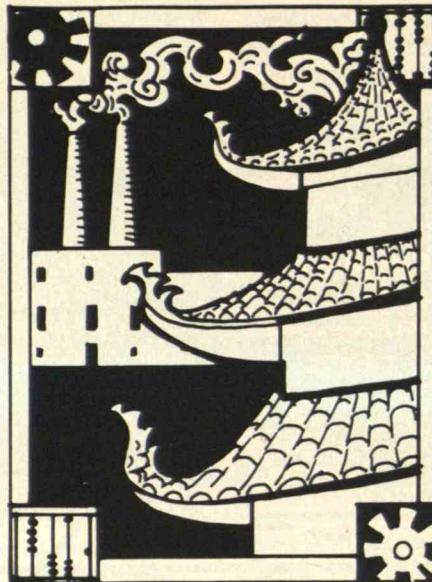
China's Dilemma: Competing Without Capitalism

To an economist, China today is like a giant laboratory. In few other countries in the world has a shift in economic orientation come so quickly and peacefully. The change is particularly striking to foreigners who regularly visit China. Two years ago, a street in Beijing was a jumble of hutongs—one-story buildings. Today, high-rise office buildings and hotels dominate the same street.

The Chinese are driven by the belated realization that while much of the world around them has been radically transformed, their economy—as of a few years ago, at least—is not much different from what it was in the 1950s. Some Western economists estimated, for example, that the per capita disposable income of the Chinese peasant in 1977 increased a mere \$10 over what it had been in 1955. China simply missed the technological revolution that was sweeping so many of its Pacific neighbors.

The Chinese found it particularly galling that South Korea, a country they had always regarded as culturally subordinate, should be on the verge of becoming a major industrial power. It was bad enough that Japan should be so successful, but South Korea had never before shown much interest in industry or technology. Even more embarrassing was the fact that Taiwan was also doing well. Taiwan, after all, was supposed to be nothing more than a renegade province of China run by a band of mercenaries who had fled the mainland after bankrupting it in the 1940s. Now Taiwan's economy was far superior to China's, not only in terms of per capita income but in terms of technological development as well.

China's leaders were determined to catch up with their neighbors. They said they would do it even if it meant a fundamental upending of their economic system. And indeed, in the last six or seven years, the Chinese economy has been transformed: the commune system of agriculture has been partially dissolved in favor of family farming, small-scale pri-



To compete with its Asian neighbors, China will have to institute major economic reforms.

vate enterprise is now encouraged, and the door has been opened to foreign investments.

But change has not come easy, and China is having a hard time catching up. In part, this is because neither its neighbors nor their technology is standing still. But China's difficulties are also due to the fact that its economic system—in terms of worker and managerial motivation—is not well suited for coping with the new economic and technological order.

Throwing Away the Iron Rice Bowl

Until recently, workers and managers “ate from an iron rice bowl”: they all received the same salary regardless of performance. Hence, there was little economic incentive

to improve productivity. The Chinese are now attempting to reward individual performance with bonuses, but insufficient incentives remain a problem in manufacturing.

Furthermore, the Chinese rely heavily on state-owned enterprises for manufacturing new products. These enterprises have been producing television sets and automotive vehicles for domestic use, but China has had little success in exporting these products. They are simply not up to world standards—again because of the lack of incentives and innovation.

The Chinese have also tried to upgrade their factories with imported machinery and processes. This has helped some Chinese manufacturers break into world markets. For example, the Beijing Printing and Dyeing Plant imported advanced textile machinery from Japan and Germany. The company has since become one of the main suppliers of fabrics to the Van Heusen Shirt Corp. in the United States. But like the textile factory, most such successes have occurred at the lower level of the technology spectrum.

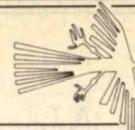
The Chinese are finding it difficult to build and operate sophisticated manufacturing systems for more advanced technologies such as electronics and computers. To manufacture such products, it is not enough to avail yourself of a few well-trained engineers or even a few turnkey factories. You need to master an entire infrastructure of technologies. To successfully produce computers, for instance, you have to know how to produce silicon wafers, how to etch integrated circuits onto the finished wafer, and how to assemble the entire hardware package into a computer. Being able to design software for the hardware is also essential to competing in this field.

To bring themselves up to speed, the Chinese have moved in a big way to attract foreign investment. The Chinese not only allow but encourage foreign corporations to open joint ventures and even wholly owned subsidiaries. The rationale for this major reversal in policy is that foreign investments will accelerate the process of technological transfer.

Unfortunately, the bulk of foreign investment in China has not involved manufacturing technology. Most of the foreign participation has come from overseas Chinese, who have decided to take advan-



MARSHALL I. GOLDMAN IS PROFESSOR OF ECONOMICS AT WELLESLEY COLLEGE AND ASSOCIATE DIRECTOR OF THE RUSSIAN RESEARCH CENTER AT HARVARD UNIVERSITY.



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tage of China's cheap labor and invested in service operations such as hotels and restaurants. Chinese officials tend to disdain such investment, which they view as an effort to take advantage of the large flow of tourists to China.

The Chinese government prefers investments such as the 3M Corp.'s wholly owned factory in Shanghai and the joint venture between the Foxboro Corp. of Foxboro, Mass., and the Chinese government in Shanghai. 3M is manufacturing pressure-sensitive tape for electrical appliances, among other products, and the Shanghai-Foxboro venture is producing sophisticated instruments to control operations in steel mills, electric-generating plants, and other such manufacturing operations.

The Scramble for Dollars

Even these foreign investments are not always as fruitful as the Chinese anticipated. Most foreign corporations find they must import the bulk of the components they use because they cannot find anything of comparable quality in China. The Foxboro Corp., for instance, which began its joint venture in 1983, was still importing 80 percent of the materials it needed from the United States in 1985. Thus, for the most part, the instruments produced by the Shanghai-Foxboro Co. were essentially being assembled from kits sent from the United States.

Importing these kits requires hard currency. Yet Shanghai-Foxboro sells almost everything inside China for domestic currency that cannot be converted into hard currency (nobody wants to buy the Chinese currency). Such joint ventures cannot find export markets because their products are not up to world competitive standards. For instance, even the kits imported by Foxboro are not assembled as competently in China as they are in the United States. As one Chinese engineer put it, "If I have to spend dollars, I will import something—not spend my dollars on products made in China." Without dollars to import components, foreign-supported companies are crippled. And the dearth of hard currency only adds to China's overall balance-of-trade problem.

There are other problems as well. Although most foreign-operated firms are required to pay salaries far above the going

rate for domestic factories, the state claims a big fraction of the wages. As a result, the workers end up receiving close to what is paid to workers in Chinese-owned operations. This causes friction among workers in Western-affiliated enterprises, particularly if they are pressured to adopt the more rigorous work habits of their employers. For instance, hotel workers are no longer allowed to take naps on the job or be as lackadaisical about guests' requests. Some employees of Western-run hotels in Beijing recently went on a slowdown to protest such pressure—an enormous irony in a country that is supposedly run for and by the proletariat.

Undoubtedly, the decision to bring in joint ventures has helped accelerate the flow of technology to China. Shanghai-Foxboro, for instance, managed to reduce the share of components it imported from the United States to 65 percent in 1986. However, if China hopes to catch up with its Asian neighbors, it will have to institute yet another dramatic shift in policy.

Almost all the newly developed countries in Asia encourage small, privately run enterprises to enter export markets. Such firms are remarkably flexible and responsive; they tend to find markets for their cheap, labor-intensive, and generally low-technology products. Equally important, these small workshops often serve as training ground for those who will become producers of more sophisticated technology. Both Sony and Honda started out this way, producing radios and small engines at low prices.

However, private enterprises in China are not allowed to hire more than seven employees—a policy that effectively limits their ability to manufacture products for domestic sale or export. To compete with its Asian neighbors, China will have to allow private entrepreneurs to build up their workforce so they can manufacture products for export. The country may also have to institute other economic reforms, such as allowing prices for food and basic services to go up according to demand. At present, most prices are controlled by the government.

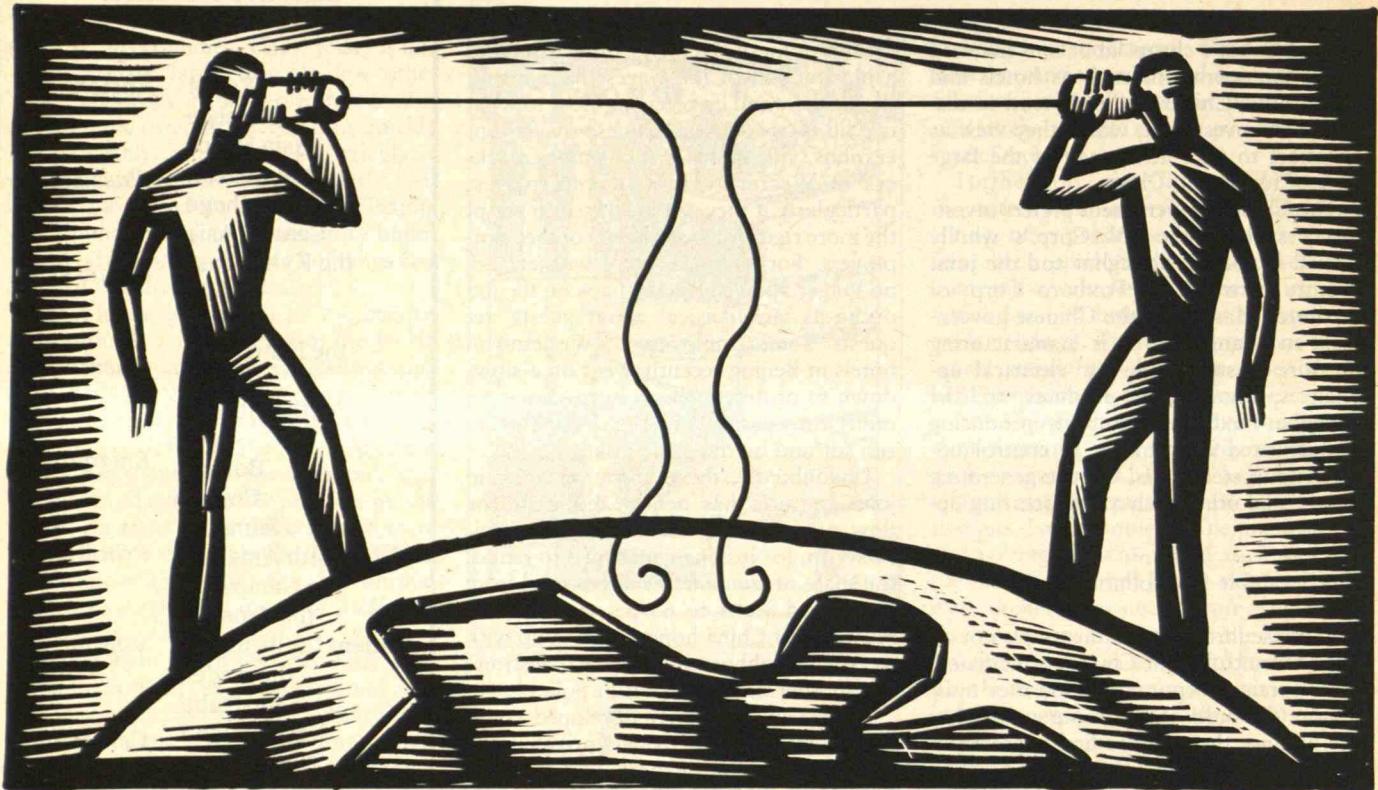
All things considered, however, China has come a long way. It will be fascinating to see whether it has the political daring and patience to go the rest of the distance required to become a formidable technological power. □

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Greece	Classical.
Asia Minor the Aegean Carthage	Mysterious.
Central Asia the Kyber Pass India Nepal	Oriental.
the Himalayas Japan	Enigmatic.
Southeast Asia Java Borneo Ceylon Sumatra	Primitive.
South America the Galapagos the Amazon	Vibrant.
Ancient Civilizations the Andes Australia	Compelling.
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No News May Not Be Good News



EARLY this decade, UNESCO touched off a major journalistic flap by accusing the Western wire services of conspiring to control the flow of information from developing nations. In the Third World-dominated General Assembly, the resulting call for a "New World Information Order," which raised fears of licensing and censorship, sent a chill through the Western press corps. Alas, lost in the West's bitter arguments about press freedom was the fact that the complaint has some validity. The global flow of information is a mere trickle when it travels East to West or South to North, and if the subject is science, that flow nearly dries up.

The limited dissemination of information into the United States from Third World countries—as well as from other developed nations—seems not so much the result of conscious neglect by a cartel of Western communications giants as a combination of parochialism, misplaced

priorities, and media economics. And both the developed and developing nations are chauvinistic about science coverage. The First World media emphasize development's dark side—wars, disasters and technical failures—while the developing nations' governments often restrict international transmission of news to high-tech projects that reflect national aspirations rather than needs.

The flow of information about science and technology can also be severely limited *within* many developing countries—restrained by illiteracy, lack of trained reporters, and hidebound scientific bureaucracies. Most important, reporting is sometimes restricted by official perceptions of what kinds of science and technology should and should not be promoted within these countries.

Why do the industrialized nations need to know about the developing world? Aside from the absurdity of remaining ignorant about two-thirds of humanity, economic self-interest suggests that an awareness of potential markets, probable competition, and possible threats to Western stability is essential. More immediate are the links between Third World events

and international crises. For example, it has become increasingly clear that the roots of the AIDS epidemic may lie in the Central African gene pool. And the unbridled destruction of the tropical rain forests of Latin America and Southeast Asia threatens to precipitate worldwide climatic change.

Obviously, the problem is not a question of no news to report. Earlier this year, at an American Association for the Advancement of Science seminar, Subbiah Arunachalam, editor of the *Indian Journal of Technology*, cited several examples of high-tech creativity emerging from India's program of economic self-reliance. They include manufacture of brake pads for MIG jets so much better than the originals that the Soviets now order these items from India; the development of a stress-relieving process for reactor vessels based on the principle of the household gas stove; and the use of ancient yoga techniques as therapy for mentally retarded children.

Yet only a little more than 10 percent of the space for news in American general-science magazines is devoted to stories coming from outside the United States, according to a year-long analysis by Fran-

JAMES CORNELL is publications manager for Harvard-Smithsonian Center for Astrophysics and president of the International Science Writers Association.

çoise Harrois-Monin, a French journalist. She found that European magazines are similarly chauvinistic, but to a lesser degree. Harrois-Monin's publication *Science et Vie* allots 58 percent of its news space to stories originating outside France (although nearly 30 percent of the total news concerns North America).

Perhaps a major factor underlying the paucity of foreign-science coverage is language. Few American journalists are comfortable with other languages, and few U.S. science magazines maintain offices abroad. The traditions of science communication in the United States are also very different from those of other countries. For example, the PR officer who helps the media gain access to scientists is ubiquitous at most U.S. universities and research centers but a rarity elsewhere. Yet the basic cause, Harrois-Monin and others suspect, may be the "best-in-the-world syndrome": perceiving themselves citizens of the "richest and most powerful nation in the world," American editors simply do not think that science done elsewhere is worth reporting.

Second-Rate Technology?

The U.S. media are not alone in ignoring much of the science conducted in developing nations. Oddly, Third World publications often do not adequately cover the science and technology issues that are important to their own countries. While spectacular but superficial science events, such as the launching of the first Indian cosmonaut, receive wide press coverage, advances such as a new and simplified biomass gasifier that could replace some 6 million diesel-run water pumps receive little or no publicity, Arunachalam points out. In India, he says, this results from "the widespread feeling that 'appropriate technology' is based on poor-quality science." Consider what Prime Minister Rajiv Gandhi told the Indian Science Congress earlier this year: "Appropriate technology to me means second rate, being deliberately kept backward so that we keep playing the game of catch-up."

Adlai Amor—deputy executive editor of the Press Foundation of Asia's DepthNews Science Service, based in Manila—believes that the scanty science coverage in the Asian press may also reflect an attitude that science and technology stories "lack the glamour of reportage on movie stars, politicians, and sports figures. For writers

The American media too often think that Third World science is not worth reporting.

hoping to make a name for themselves, reportage on applied research will not land them on the front page."

At least in India and some other Asian countries, decisions about what goes into print are still made by editors and journalists. In Sub-Saharan Africa, science "news" is more often selected by the government. There, the main, if not only, sources of scientific and technical information are government ministries, points out Jean-Marc Fleury. He spent five years in Senegal as a representative of Canada's International Development Research Centre (IDRC), which promotes science journalism in Third World countries. Since ministry officers usually have little experience or ability in science communication, the news they release is shallow, typically describing the administration, structure, and objectives of research organizations rather than the research. A typical story on a scientific conference lists attendees and the program's topics, and perhaps reprints the opening address. There is little attempt to report research results, and certainly no interpretation of their implications or applications. It's no wonder that, as Fleury points out, "for several weeks in a row, the science pages of the Ivory Coast's [newspaper] *Fraternité-Matin* carried large sections taken directly from the theses of the latest graduates of the School of Medicine."

Such reporting, whether by the government or journalists, would be laughable if it did not have tragic consequences. In India, news of improved and inexpensive latrines goes undisseminated to villagers who need them. And many state-controlled presses in Africa still refuse to acknowledge the severity of the AIDS epidemic in Africa, calling it a fabrication of the Western media. In the meantime, an endangered populace receives no warning about the use of contaminated needles

by traditional healers, a suspected factor in the disease's spread.

What remedies are there for improving the information flow within Third World countries and to the West?

First, Western editors need to leave their desks to visit and live in Third World countries. No more than 100 of some 1,700 daily U.S. newspapers employ full-time foreign editors, and few have extensive experience in the developing world, notes Brennon Jones. His New York-based Interlink Press Service provided Third World coverage to U.S. media until it was disbanded this year because of a lack of subscribers.

The larger news services, both European and American, should establish correspondents in capitals off the beaten path in addition to the standard posts in New Delhi, Hong Kong, Nairobi, and Mexico City. Unfortunately, the cost to maintain a correspondent abroad averages about \$200,000 annually. But major publications could at least supplement standard wire stories with others from news organizations such as Gemini and Earthscan, both based in London and specializing in development issues. In addition, they might tap into fledgling Third World news services such as DepthNews, the Press Trust of India, the All-African Press Service, and the Pan-African News Agency.

Meanwhile, Third World nations must improve science coverage. Developing countries are receiving a boost toward this end from Canada's IDRC. In addition to training young science reporters in Third World nations, that organization has funded DepthNews Science and the Pan-African News Agency's "Science Bulletin"—respectively, monthly feature services for Asia and Africa.

In countries where either politics or philosophy now determines what stories are published, more innovative approaches are needed. An excellent opportunity may be at hand. Last year the prestigious International Council of Scientific Unions decided to explore ways to disseminate scientific and technical information worldwide. One step under consideration is to bring scientists and journalists together for sessions on topics of interest to developing countries. Such open forums would not only focus international attention on subjects otherwise unreported, but might begin the slow process by which developing countries become both recipients—and sources—of science news. □

Reforming Our Malpractice System

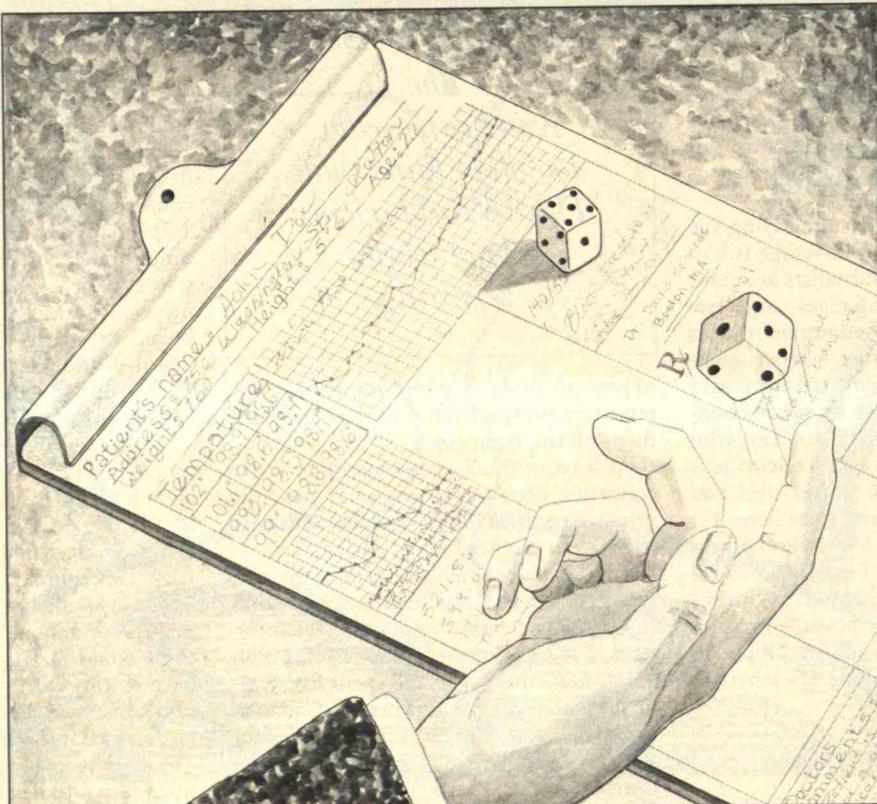
THE current crisis in liability insurance creates an extraordinary opportunity to reform a system that is wasteful, arbitrary, unpredictable, and unfair. At a time when most people agree that something must be done to stop spiraling insurance premiums and declining services, policymakers should seize the opportunity to overhaul a system that cannot provide justice in a technologically complex society.

Nowhere is the insurance crisis more acute than in the field of medicine. Malpractice insurance premiums rose 17 percent between 1983 and 1984, and doctors in some high-risk fields have seen their premiums as much as triple in a year. In response, a small but growing number of doctors have simply left high-risk medicine. That is why women on the Hawaiian island of Molokai—which is not sparsely populated—must now fly to Oahu or Maui to find a doctor willing to deliver a baby. Worst of all, the present system permits a small number of malpractice victims to recover million-dollar awards, while many who deserve compensation never bring suits because of the emotional and economic costs of doing so.

Blame for the crisis can be shared widely. In one sense, the medical profession has brought on the problems by failing to police incompetent doctors adequately. Judges and juries have not always acted responsibly in finding fault and assessing damages. And lawyers, who are paid a percentage of the damages, ob-

viously benefit from disproportionately large jury verdicts. Insurance companies have also played a major role in creating today's problems. Their premium rates have shot up since their profits declined—after they tried in the late 1970s and early 1980s to increase their business by undercutting one another's rates. Recently it has been convenient for these companies to use the publicity about malpractice lawsuits to cover up their past problems. But they have legitimate concerns about the unpredictability of today's lawsuits.

Merely tinkering with the current mal-



We need a compensation system that provides relief for the victims of legitimate medical risk.

practice system, such as by setting caps on liability awards, will not get at the root of the problem. The basic difficulty is that the system focuses attention on punishing wrongdoers instead of on compensating victims. Furthermore, it protects consumers from only one very specialized type of risk, negligence, although many other risks have been created by advances in technology.

The basis for the skewed focus lies in the nature of the tort liability system itself. A tort is a legal wrong committed by one party upon another. Under the current system, a malpractice

victim is supposed to recover damages only after showing that his or her doctor acted negligently—without "due care" or "reasonable precautions." If negligence and injury are proven, the judge or jury can award compensatory damages for medical costs, lost income, and the like, as well as punitive damages—in effect a fine intended to deter future negligence by that doctor or others.

If negligence cannot be shown—if the injured party is truly the victim of an accident—no compensation is supposed to be awarded. Hence, according to a strict interpretation of the law, many injured persons should receive nothing. But many end up winning out-of-court settlements from doctors who fear that juries, sympathetic to permanently injured or disfigured victims, might award huge damages even when negligence has not taken place. The victims seem to deserve and require some sort of compensation, and the defendants, who are usually insured by large companies, can afford it.

Perhaps in earlier times it made sense to compensate only those injuries that were the direct result of negligence and to ig-

WILLIAM LASER is assistant professor of public law in the Political Science Department at Clemson University.

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more all others, on the theory that injuries were an unavoidable consequence of living in an imperfect world. People became sick; doctors did what they could, but no one expected very much.

Today, however, we assume that all disease is treatable, that all illness and injury are preventable. If something goes wrong, patients blame the doctor. Parents of malformed children now sue their obstetrician for “wrongful birth,” seeking compensation for the financial and emotional costs of caring for their children. Others sue because a prescribed drug has an unfortunate side effect, or because a surgical procedure fails.

Americans need to better understand the nature of medical and technological risk. Whenever doctors perform a procedure, they and their patients accept a small but definable risk of some adverse effect. Every drug prescription represents a gamble—a gamble that the medicine will help rather than hurt.

A Better Compensation System

A properly devised liability arrangement would provide relief not only for the victims of negligence, but also for the victims of legitimate medical risk. Such compensation is especially appropriate when the risks are truly unavoidable. Consider how such a setup would work in the case of DPT vaccinations, which most states require children to receive for protection against diphtheria, pertussis (whooping cough), and typhoid. The vaccine can cause serious neurological damage in a small percentage of recipients and some studies suggest that it may induce sudden infant death.

The money backing a system that compensates such victims would come from a surcharge on the vaccine. The surcharge would be paid by the buyer, which can be state governments, the federal government, or patients. No matter who initially paid the extra fee, the costs might be more than recouped if manufacturers passed along their savings on insurance as lawsuits decreased. Even if total costs rose owing to an increase in the number of victims claiming compensation, the additional expense would probably be small. Furthermore, it would be a cost society should pay, since it deems that DPT vaccinations are important.

Compensation would be paid to victims according to the costs of medical treat-

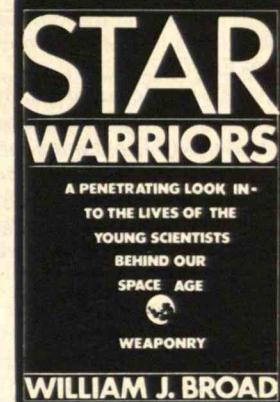
ment and the loss of future pay, for example. An average of more than \$300,000 could be made available to each patient seriously injured by the DPT vaccine if \$1 were surcharged per dose, since about three cases of brain damage occur per million doses.

It would be important to back up the entire program by federal statute. The law would have to place strict limitations on the right of patients to sue if they accepted automatic compensation, to prevent them from possibly claiming negligence when it has not taken place. The law would have to require victims suing for punitive damages to prove gross negligence—action in “reckless disregard” of the consequences. That is tougher than proving simple negligence. The law might also place a cap on total damages to prevent awards that are out of proportion to others in similar cases.

If such a system proved effective for compensating vaccination victims, the idea could be expanded to other areas of medicine. Victims of any procedure involving risks worth taking—and in which the odds of an adverse occurrence are reasonably easy to calculate—could be assured of compensation. For example, a newborn who suffered brain damage as a result of a doctor’s reasonable decision not to perform a caesarean section—a procedure that decreases the risk to the infant but greatly increases the mother’s risk—could receive compensation. In fact, a mother who voluntarily underwent a C-section to protect her baby might receive compensation if injured by anesthesia.

Currently, Congress is considering several proposals to compensate DPT vaccine victims. Most of these establish mechanisms to settle claims before they reach the courts and place a cap on damage awards. Several bills propose a compensation system similar to that described here except that most would provide compensation from existing federal funds. Action on those bills seems to have stalled because of the current budget concerns in Congress. The bills might have better success if the compensation funds were raised by a surcharge paid by the vaccine buyer. Sometimes that might be the U.S. government, but it should not always have to pay.

Such an approach may seem radical when compared with the current system of liability insurance, but it is well within the tradition of insuring individuals against loss by pooling risk. □



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ASSESSING SOVIET WEAPONS

Louis Lavoie's article confirms my suspicion that our technology is more powerful than Moscow's ("The Limits of Soviet Technology," November/December, page 68). But I think it is important to understand that the Soviets are a pragmatic people. They realize their weaknesses and work around them. For instance, if our technical advantage caused them to lose three tanks for each one of ours, they would bring four to bear. Also, their Sputniks may not have produced any scientific data, but they did serve their intended purpose, which was to demonstrate their ability to carry payloads over the United States. And if the Soviet MIG-25 burns out after one flight, it is of no consequence: the plane was designed solely to intercept U.S. bombers in a nuclear attack. Only one flight is necessary.

Although the Soviets may solve prob-

lems by brute force, they do get them solved—at least the ones that they think count.

RALPH WILLIAMS
Vienna, Va.

BRIDGING THE TECHNOLOGICAL COMMUNICATION GAP

In "Toward Liberal Learning for Engineers" (February/March, page 18), Samuel Florman seems to assume that engineers should have the sole responsibility for bridging the communication gap between the technological community and the general public. I believe that the general public should share the responsibility. If engineers are required to study the arts, then shouldn't we insist that all liberal-arts students study engineering? An education in the arts may bring some engineers precious insights into literature, history, and philosophy, but a knowledge of quantum physics may bring philosophers, lawyers,

journalists, and legislators insights that are just as precious.

In fact, it could even be argued that technical training is more important to liberal-arts students than liberal-arts training is to those who wish to pursue a high-tech career. Because engineers can read, they can study Greek drama, Roman history, or the writings of Karl Marx any time they want to. But no one without the right background can use a text that describes the technology of communicating across countries or air-conditioning a home.

PETER MILITCH
Laurel, Md.

The University of Rochester has recently initiated a program called Take Five, which addresses some of Samuel Florman's concerns.

In this program, selected engineering students enroll in a fifth year of undergraduate courses without paying any ad-

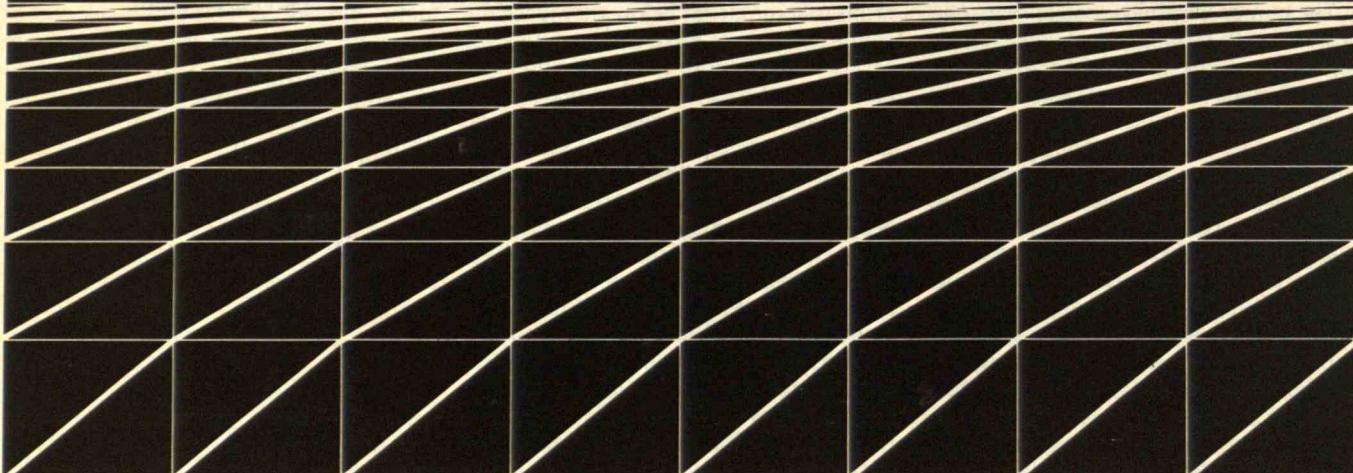
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ditional tuition. These students are expected to present a well-thought-out plan for liberal-arts study that would not fit within the boundaries of the usual four-year baccalaureate programs. Current plans include work in studio arts, ethics, and Japanese language, history, and culture. Some Take Five participants have even been approved for study abroad.

KEVIN J. PARKER
Rochester, N.Y.

Kevin J. Parker is an associate professor of electrical engineering at the University of Rochester.

Maybe it is true that most engineering students "want to maximize their immediate chances in the job market and minimize the cost of pursuing degrees." The reason might be that a greater proportion of engineering students are supporting themselves. When I think of all the liberal-arts graduates who are totally unprepared for gainful employment, I can't help but view their education as expensive recreation.

ROBERT J. LAUF
Oak Ridge, Tenn.

Florman complains that engineers are not encouraged to attend professional school after receiving their undergraduate training. But in the last year or so, I have seen

two developments in Silicon Valley that may point to a trend: more high-technology companies are inserting the words "M.S. preferred" into their recruiting ads, and two local colleges now offer special two-year master's programs in engineering and computer science for liberal-arts graduates.

DIANE L. OLSEN
Palo Alto, Calif.

I agree that we need engineers with a liberal-arts background. In the past, engineers with such a background have made important contributions to society. For example, Allen Hazen (1869-1930), a broadly educated American sanitary and hydraulic engineer, played an important role in developing the water-purification technology that was widely used at the turn of the century to reduce water-borne disease. He was respected for his ability to communicate his ideas clearly, and he actively sought to tell people how technological advances could help cities and towns solve sanitation problems.

DENNIS J. SEBIAN
Andover, Mass.

The problems Florman describes are apparently specific to American engineers. Engineers of other nationalities do not experience them. For example, in the so-

called Third World countries, the average educated individual is more "cultured" than the average U.S. citizen and more interested in the social sciences. After almost 30 years of attending national and international engineering meetings, I have noticed that the number of papers dedicated to the social aspects of the profession are greater among Third World authors than among U.S. ones.

Perhaps U.S. high-school curricula could be beefed up so that very few liberal-arts courses would have to be required in college. This is what several South American countries do.

MAURICIO CASANOVA B.
Caracas, Venezuela

NAME THAT PLANT

The caption for the photographs in Steve Nadis' "Endowed Plants" (May/June, page 12) reverses the names of the beautiful plants shown. *Iris lacustris* is the purple one, and *Carpenteria californica* is the white one.

G.R. WHITNEY
Chicago, Ill.

Oops . . . Though Carpenteria may not be a familiar species, Iris is easily identified even by horticulturists of our amateur standing. Sorry for the error, and thanks for correcting us.



PHOTO: U.S. NAVY

How the Next War Will Be Fought

THE year is 1995. Two industrialized countries are at war. One side decides to invade and occupy the other. Its tanks, in regular columns, approach the no man's land at the border between the two combatants.

Suddenly, without warning, small missiles silently attack the invading tanks. Each missile hovers momentarily above the tanks, selects one and attacks it by firing a high-speed projectile at the weakest part—the turret and engine cover. The deadly accurate missiles are very selective: they don't attack any tank that has been selected for attack by another missile. These missiles are fired from 30 or 40 kilometers away, far beyond the range of the tanks' guns. Few survivors crawl out of the burning wrecks, since red-hot pieces of metal ricochet around inside and hot, suffocating gases spread rapidly throughout. Only three of the tanks survive. Their morale completely shattered, the crews decide to retreat.

This scenario is more than a fantasy in the minds of military planners in the Pentagon and the Kremlin. As recent conflicts in the Falkland Islands and the Middle East have shown, modern warfare relies increasingly on such smart missiles.

These weapons are becoming more sophisticated every day. A main aim of current military technology is to develop missiles that are effective under all the adverse conditions under which battles are fought: when the battlefield is covered with thick smoke and dust; in heavy rain and snow, thick fog, and haze;

and against electronic jamming devices, decoys, and other enemy countermeasures designed to confuse radars. Strategists can now foresee the "brilliant" missile that can find its target and attack it without instructions from any external source.

Advanced missile technology is already beginning to transform warfare. Battle tanks, long-range combat aircraft, and warships are, or will soon become, obsolete now that they are faced with accurate, intelligent missiles. These missiles make it much cheaper to destroy the weapons of invasion than to buy them. Thus, defense can be made much more cost-effective than offense. This has important implications for NATO. The alliance can use the new technologies to provide an effective deterrent based on non-nuclear weapons against an attack by Warsaw Pact forces.

Developments in military technology are well illustrated by considering the development of anti-tank missiles. A typical anti-tank missile now in operation is the U.S. TOW (tube-launched, optically tracked, wire-guided) missile, which was used ex-

FRANK BARNABY is the former director of the Stockholm International Peace Research Institute. During the 1950s he worked as a physicist at the British government's Atomic Weapons Research Establishment. He has held appointments at University College in London, the Free University in Amsterdam, and the University of Minnesota. He is now chairman of Just Defence, an Oxford-based organization that promotes a stronger non-nuclear defense for NATO. This article is adapted with permission from Barnaby's forthcoming book, *The Automated Battlefield*, © 1986 The Free Press.

Sophisticated new missiles are making tanks, combat aircraft, and large warships obsolete. NATO can use these missiles to create a safer, more effective defense for Europe.

BY FRANK BARNABY



tensively in the Vietnam War and in wars in the Middle East. Altogether some 400,000 Tows have been produced.

TOW is popular because it destroys tanks very efficiently and because it is relatively cheap; each \$15,000 missile has a high probability of destroying a main battle tank costing \$3 million or more. (All of the prices in this article are in 1985 dollars.)

TOW is carried in a jeep, armored car, or helicopter. The operator of the missile looks through an optical sight and pinpoints an enemy tank. The operator then presses the trigger and a rocket motor propels the missile from the launch tube. As soon as the missile emerges from the tube, small wings unfold and an infrared flare in the missile's tail ignites.

The operator's viewing system tracks the position of the flare relative to the line of sight between the operator and the tank. If the missile strays from the line of sight, a computer sends a command to the missile along two fine wires attached to the missile;

the wires unwind from bobbins on the missile as it flies. So long as the operator keeps the cross-hairs in the viewer on the target, the missile will follow the line of sight. A modern TOW, which has a range of nearly four kilometers, carries a warhead capable of penetrating the armor of all existing tanks.

The TOW missile is one of an international family of anti-tank missiles. Others include the Soviet Sagger, used by the Syrians against Israeli tanks in the 1973 Middle East War; the British Swingfire; and the European Milan system.

But anti-tank missiles such as these have their limitations. One is that the operator of a TOW-type missile must remain within range of enemy fire while the missile is in flight, and, the enemy can determine the spot from where the missile is fired. Another problem is that missiles guided by infrared can be easily decoyed by infrared flares or burning vehicles near the target.

Many of the disadvantages of wire-guided missiles



Modern tanks such as the U.S. Army's M-1 (far left) are faster, sleeker, and more powerful than their World War II predecessors. However, they are vulnerable to anti-tank missiles. Armed forces around the world use the inexpensive and reliable U.S. TOW missile (left). A U.S. Apache attack helicopter (above) can carry 16 laser-guided Hellfire missiles, making it a formidable weapon against armored vehicles. The next generation of anti-tank weapons will use "sub-munitions." One missile will contain smaller missiles capable of attacking enemy tanks with deadly accuracy.

are eliminated in the new generation of anti-tank missiles, just entering the arsenals. An example is the U.S. Hellfire (heliborne-launched fire-and-forget) missile, which is guided to an enemy tank by a laser beam projected toward the tank. A sensor detects the light reflected from the tank and the missile, as it were, rides down the beam to the target.

The person operating the laser does not need to be in the vehicle firing the missile. Normally, Hellfire missiles are carried on helicopters, and the laser operator can be on the ground or in another helicopter. This gives the missile a big advantage over systems such as TOW, since the enemy cannot pinpoint the operator by observing the missile's launch site.

Hellfire missiles are mainly carried on the U.S. Apache AH-64 advanced attack helicopters. Each helicopter carries up to 16 missiles, which can be launched in salvo. Several lasers are used simultaneously, each using a different pulse frequency. Each missile responds to one of the frequencies and is

guided individually to its target. The Hellfire carries a 175-millimeter warhead, effective against all existing battle tanks. A small squadron of Apache helicopters armed with Hellfires is therefore a formidable anti-tank force, able to knock out a relatively large number of attacking tanks. At \$40,000, the Hellfire is more expensive than the TOW, but it is still relatively cheap since it stands an excellent chance of destroying a \$3 million tank.

The third generation of anti-tank missiles now under development will use "sub-munitions," in which one missile contains a number of smaller missiles each able to attack an enemy tank separately. These warheads, which will be carried by, for example, the new Standoff Tactical Missile, could quickly attack many armored vehicles spread over a large area.

The system operates with radar carried in an aircraft or a remotely piloted vehicle (RPV), an unmanned plane controlled by radio. First, the radar seeks out and tracks moving targets such as tanks

that may be far inside enemy territory. A signal sent from the aircraft or RPV launches the missiles. The radar guides them into the air above the tanks, where they release their sub-munitions to attack the enemy forces. Each submunition is a "smart" missile, capable of what is called "terminal guidance." Each scans the target area with its own sensor, homes in on a tank turret, and fires a high-speed projectile. Since each warhead may carry 20 sub-munitions, and it may take an average of two to destroy a tank, each missile could destroy ten tanks—making it a formidable anti-tank weapon.

An example of a sub-munition being developed for the Standoff Tactical Missile is the Skeet, a smart bomblet weighing about 2 kilograms and carrying a 0.5-kilogram warhead. The bomblet wobbles as it falls to enable the infrared sensor in its nose to scan the terrain under it. If the Skeet "sees" an armored vehicle, it fires a warhead. If it doesn't detect a target, Skeet is programmed to explode anyway, scattering a large number of metal targets to destroy soft-topped vehicles and kill people in the area.

An effective anti-tank defense would consist of obstacles and sophisticated mines to slow down advancing enemy armor, as well as intelligent warheads to destroy the armored vehicles. Tanks would find it very difficult to penetrate territory defended with such weapons. As anti-tank weapons become smarter, the difficulty of invading with tanks will increase.

Anti-Aircraft Missiles

Aircraft, like tanks, are becoming more vulnerable to successive generations of intelligent missiles. Air defenses are already difficult to penetrate. According to NATO estimates, at least half of the attacking aircraft would be lost in a raid on a heavily defended area in Warsaw Pact territory, such as a main military air base.

Modern radars allow air defenses to track many enemy aircraft at the same time, no matter at what altitudes the aircraft are flying, and to guide many surface-to-air missiles to their targets simultaneously. Advanced "phased-array" radar used by, for example, the American Patriot missile system gives early warning of an air attack and tracks the hostile aircraft. A central computer analyzes the data from the radars, fires surface-to-air missiles at the right moments, and guides the missiles accurately to their



Improvements in fuel, propulsion, and guidance are revolutionizing anti-ship missile technology. Billion-dollar warships are now threatened by missiles that cost less than \$1 million each. A modern anti-ship missile such as the British Sea Eagle can select and attack a specific ship in a group, even if it is heavily protected with electronic

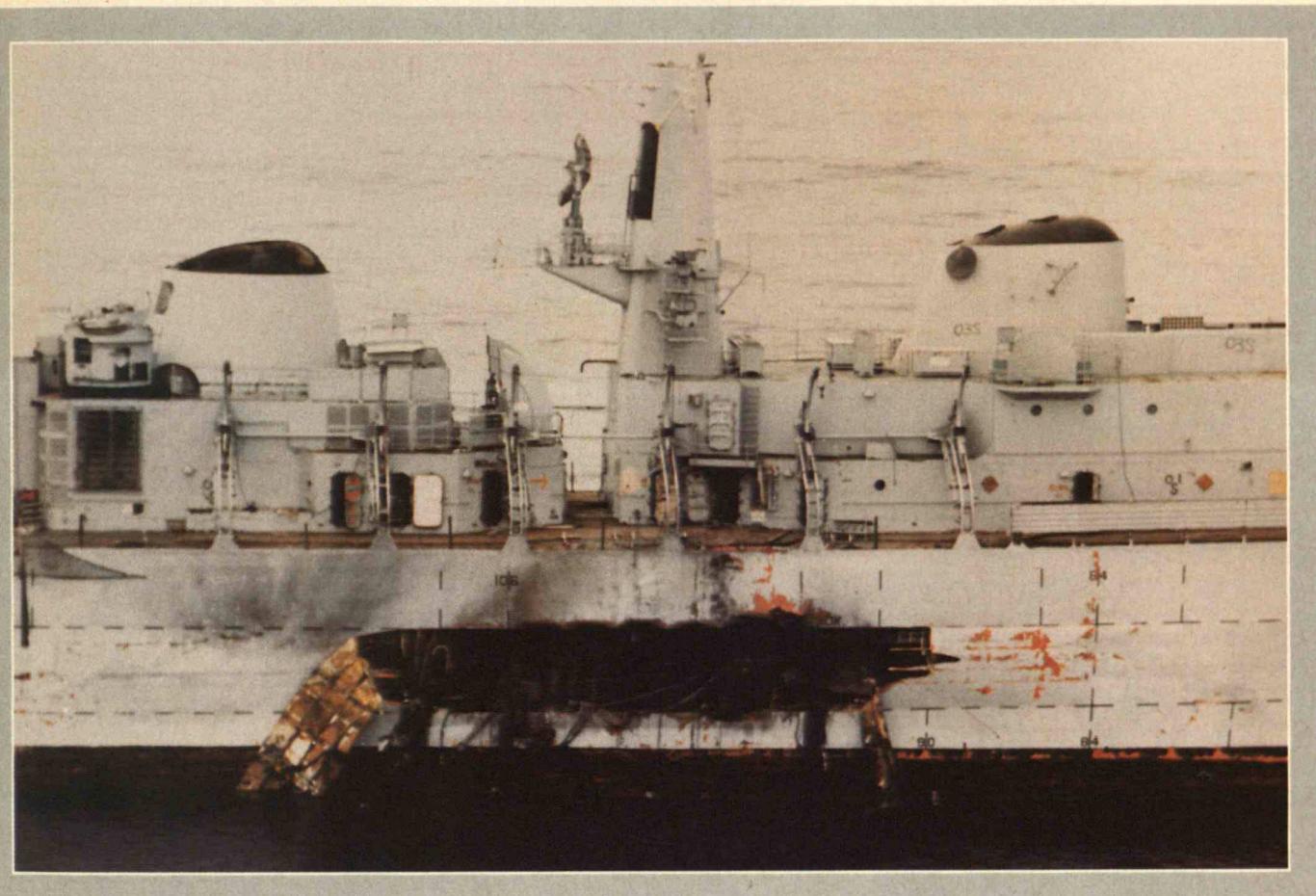
countermeasures. Right: A target vessel moments after being hit with a Sea Eagle. New missiles also are threatening combat aircraft. The U.S.-built Phoenix (above) is the world's most sophisticated air-to-air missile. When the Phoenix arrives within about 20 kilometers of an enemy aircraft, it turns on its own homing radar.

targets. An eight-missile Patriot battery can keep track of a hundred aircraft and fire on nine of them with nine different missiles at the same time. The missiles reach speeds six times the speed of sound, and can attack enemy aircraft at distances of about 70 kilometers and at altitudes up to 24 kilometers.

The Patriot is largely automated, the only manned equipment being the central control station containing the main computer and 12 people. Patriot missiles cost about \$1.5 million each, but combat aircraft cost much more. A modern strategic bomber, for example, costs well over \$200 million, and a multi-role combat aircraft such as the European-built Tornado costs about \$30 million. The U.S. Army plans to deploy 54 batteries of Patriot missiles in Central Europe by the early 1990s.

Patriot missiles are generally meant for use against high-flying aircraft. Smaller surface-to-air missiles are normally used to defend against low-flying aircraft. This family of missiles includes the Swedish

A \$15,000 TOW missile stands an excellent chance of destroying a battle tank costing \$3 million or more.



Bofors RB-70, the British Blowpipe and Rapier, the Soviet SA-6 and SA-8, and the American Stinger. The RB-70, Blowpipe, and Stinger are portable, carried and fired by one person. The Rapier is more sophisticated than the hand-held types, with missiles loaded in a launcher and carried in an armored vehicle, ready to fire.

The Rapier launcher is equipped with a surveillance radar to detect aircraft, which it interrogates using an "identification friend or foe" (IFF) system. If the aircraft fails to give the correct coded response, the launcher automatically turns toward the aircraft and the crew is alerted. The operator views the target through an optical sight and fires a missile that is automatically guided to its target. In bad weather or at night, a radar tracker can be used instead of optical viewing, with commands transmitted to the missile by microwave radio signals.

Combat aircraft are threatened not just from the ground but from other aircraft as well, so they carry

sophisticated air-to-air missiles. The U.S. Air Force and Navy, for example, use the Sidewinder, the Sparrow, the Phoenix, and the new AMRAAM advanced medium-range air-to-air missile. AMRAAM is an all-weather missile with its own active radar that gives it a "fire-and-forget" capability: it can seek out an enemy aircraft, identify it, and attack it without any further instructions from the pilot. Other current medium-range air-to-air missiles are guided to their targets by the radar systems on board the aircraft that launches them. The aircraft must stay in the neighborhood until the missile arrives at the target, making the plane vulnerable to enemy air defenses.

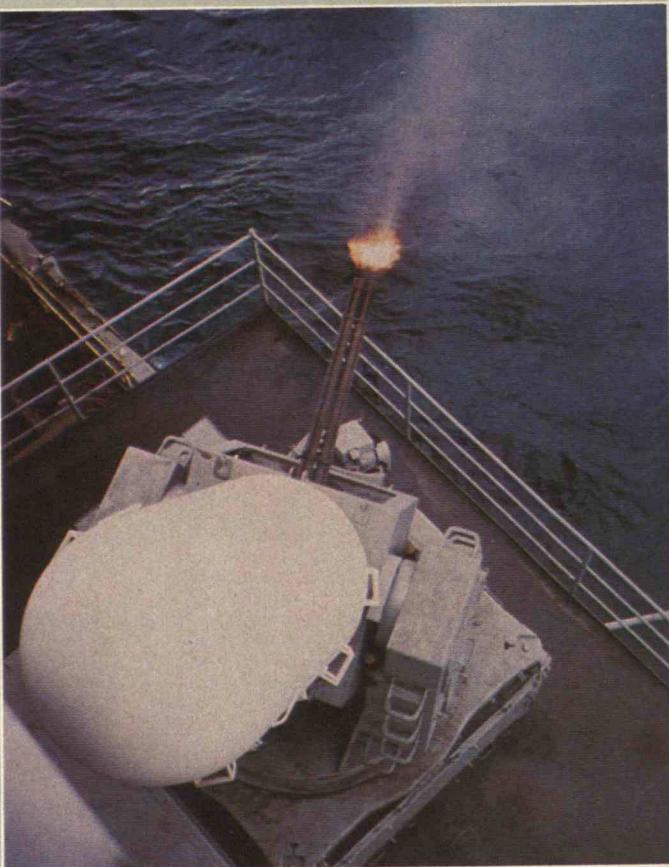
An aircraft carrying several AMRAAM missiles will be able to engage several enemy aircraft. Each missile will be able to isolate its own target, skipping over targets already chosen by other missiles. However, the missile will be relatively expensive, costing about \$2 million. The U.S. Air Force and Navy plan to begin deploying AMRAAM soon.

*During the Falklands conflict,
114 planes were shot down, the majority by
smart missiles.*

1985 PRICE LIST: MAJOR WEAPON SYSTEMS AND MISSILES

M-1 main battle tank (U.S.)	\$3 million
TOW anti-tank missile (U.S.)	\$15,000
Aircraft carrier (U.S.)	\$3 billion
Frigate (U.K.)	\$50 million*
Exocet anti-ship missile (Fr.)	\$250,000
B-1B strategic bomber (U.S.)	\$210 million
Phoenix air-to-air missile (U.S.)	\$1.3 million

*Price for the HMS *Sheffield*, built in 1972.



Modern radar, surface-to-air missiles such as the Patriot, and air-to-air missiles such as the AMRAAM are making combat aircraft increasingly vulnerable. As intelligent missiles become even more sophisticated, it will be even harder for aircraft to survive in battle.

The War at Sea

Of all major weapon systems, large warships are the most vulnerable. New propulsion units, more efficient fuels, improved guidance systems, and better warheads have revolutionized anti-ship missiles.

These missiles have a simpler job than anti-tank and anti-aircraft missiles because it is much easier to guide missiles accurately over sea than over land, and it is easier to locate and track enemy warships than hostile tanks and aircraft.

The use of both types in recent wars has brought home their effectiveness. As early as 1967, the Is-

raelis were shocked when their biggest naval ship, the *Elath*, was sunk by a Soviet-supplied anti-ship missile fired by the Egyptians at a range of about 20 kilometers. Air-launched, sea-skimming missiles became famous during the 1982 Falklands War when the Argentinians used the French-built Exocet missile to sink the British frigate *HMS Sheffield*.

The Exocet was launched by an Argentinian Navy Super Etendard fighter bomber, also bought from France, 35 kilometers away from the *Sheffield*. The 4,000-ton warship, built in 1972 at a cost of \$50 million, carried some of the world's best defenses, including Sea Dart ship-to-air missiles. Yet it was sunk with a \$250,000 missile.

The Exocet missile, which carries a 160-kilogram high-explosive warhead, is powered by a two-stage rocket that can be launched from land, sea, or air. Its maximum range is about 70 kilometers. After the missile is launched, its radar homes in on the target and guides the missile so that the warhead penetrates



Above: Fire broke out aboard the British frigate *HMS Sheffield* after it was hit by an Exocet missile during the 1982 Falklands War. The Argentinians fired six of these French-built weapons during the

conflict. Four of them hit their targets. Left: The Phalanx weapon system is a U.S. warship's last line of defense against anti-ship missiles. The gun fires 3,000 rounds per minute, creating a "wall" of bullets.

the enemy ship and explodes inside it.

The missile that sank the *Sheffield* was one of six Exocets fired by the Argentinians during the Falklands War. Four of the six hit their targets—a good success rate considering that the Argentine forces had only recently acquired Exocets and were not familiar with them.

Anti-ship missiles are of two basic types: one fired by a ship against another, the other fired by an aircraft at a warship. A typical modern ship-to-ship missile is the American Harpoon, which can be fired from the standard torpedo tubes of American submarines and those of many other nations.

The Harpoon's computer-controlled guidance system is remarkably effective: it steers the missile toward the chosen target even if it is fired in the wrong direction. The parent ship's over-the-horizon radar can determine the locations of targets at the extreme of the missile's range.

Once fired, Harpoon is independent of its parent

ship; it is a genuine fire-and-forget missile. When Harpoon gets close to the ship, a radar seeker searches the area, finds the target, and locks on it. The seeker commands the missile to gain height to outmaneuver the target ship's defenses and then dive down on it from above. The missile can also continue skimming the surface of the sea and strike the target just above the water line.

Intelligent anti-ship missiles such as Harpoon make large warships obsolete, at least against a sophisticated navy. Large warships are extremely expensive—a modern aircraft carrier costs about \$3 billion and a destroyer or cruiser costs about \$1 billion. Such warships can be destroyed by a Harpoon missile costing about \$800,000. In fact, the only naval ships that make military sense today are submarines and fast, small (about 200 tons) patrol boats armed with missiles. It is a sobering thought that a small missile-armed patrol boat can carry as much firepower as a cruiser or destroyer of the Second World War.

Missile Countermeasures

Recent military experience has confirmed the growing vulnerability of tanks, aircraft, and warships. The first dramatic demonstration of the new vulnerability of tanks came during the 1973 Middle East war, when more than 1,500 Arab and Israeli tanks were destroyed in a few days by anti-tank missiles and guns. The experience spurred the search for countermeasures against intelligent missiles, but the tank is still losing in the measure-versus-countermeasure race.

The pro-tank lobby is strong, however, and the world's major armies are still buying main battle tanks in large numbers. The United States wants to deploy about 7,500 M-1 tanks by the early 1990s, producing them at a rate of 70 a month. NATO already has some 20,000 tanks in active service, while the Warsaw Pact has about 50,000.

Today's tanks are faster, sleeker, and heavier than their counterparts of the Second World War. They also have much longer ranges and are much better armored. The front of the American M-1, for example, is protected by a shield up to half a meter thick. However, other parts of the tank are much less well protected, with the top and sides of the turret, the hatches, and rear portions carrying relatively little armor. These areas are lightly protected

because the turret must be light enough so that its heavy gun can be rapidly rotated and the hatches must be opened and closed quickly.

The upshot is that the tank is very vulnerable to attack from the sides, rear, and air. Even the front of the tank is vulnerable, since the latest anti-tank warheads are capable of penetrating more than a meter of the best armor.

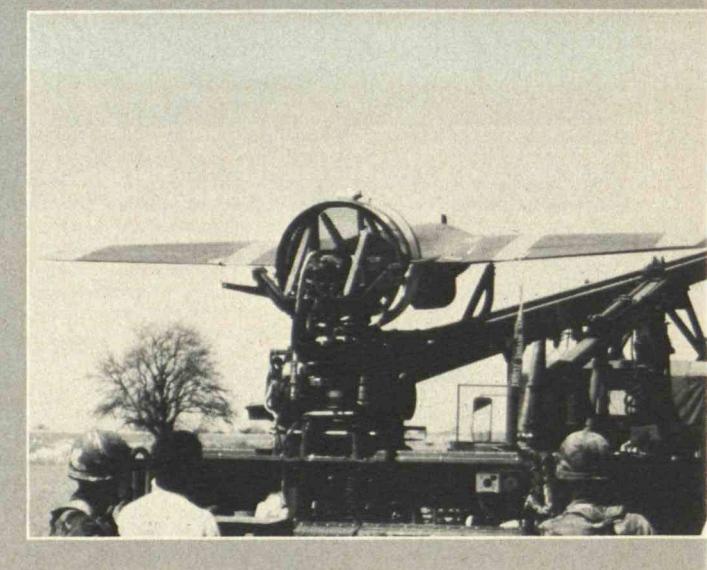
For example, the widely used HEAT (high-energy anti-tank) anti-tank warhead is much more able to penetrate thick armor than the more traditional kinetic-energy projectile, which relies on mass and velocity to force its way through the armor. On impact, a HEAT warhead produces a metal plug and a concentrated jet of molten metal. The plug penetrates the armor of the tank, and a stream of molten metal and hot vapor enters the hole and fills the space inside. This kills or disables the crew by setting the tank on fire or exploding its ammunition.

The most recent innovation to reduce the effectiveness of anti-tank warheads is "active armor." Bricks containing an explosive are attached to the front of the tank. Sensors detect an approaching missile and explode one or more bricks to destroy the warhead before it can significantly damage the tank. Israeli tanks use active armor, and it has been reported on Warsaw Pact tanks in East Germany.

Active armor can be overcome by fitting anti-tank missiles with two warheads timed to explode with a short delay. The first warhead sets off the explosives in the active armor, deactivating it so the second warhead can penetrate the tank's armor. Nevertheless, the development of active armor has decreased confidence in warheads aimed at the fronts of tanks, and has increased interest in weapons that attack tank turrets from above—such as sub-munitions.

Perhaps the most critical factor in judging the usefulness of the main battle tank versus the anti-tank missile is the range at which the two can engage targets. The best tank guns are not very effective beyond about two kilometers, yet even small anti-tank missiles such as TOW are effective at longer ranges.

A modern main battle tank may be sleeker and more difficult to spot by eye than older tanks. But its exhaust gases typically have temperatures above 800° C. The large amount of heat that a tank gives off makes it very "visible" to infrared sensors. Moreover, countermeasures such as flares, decoys, and electronic jamming are proving much less effective

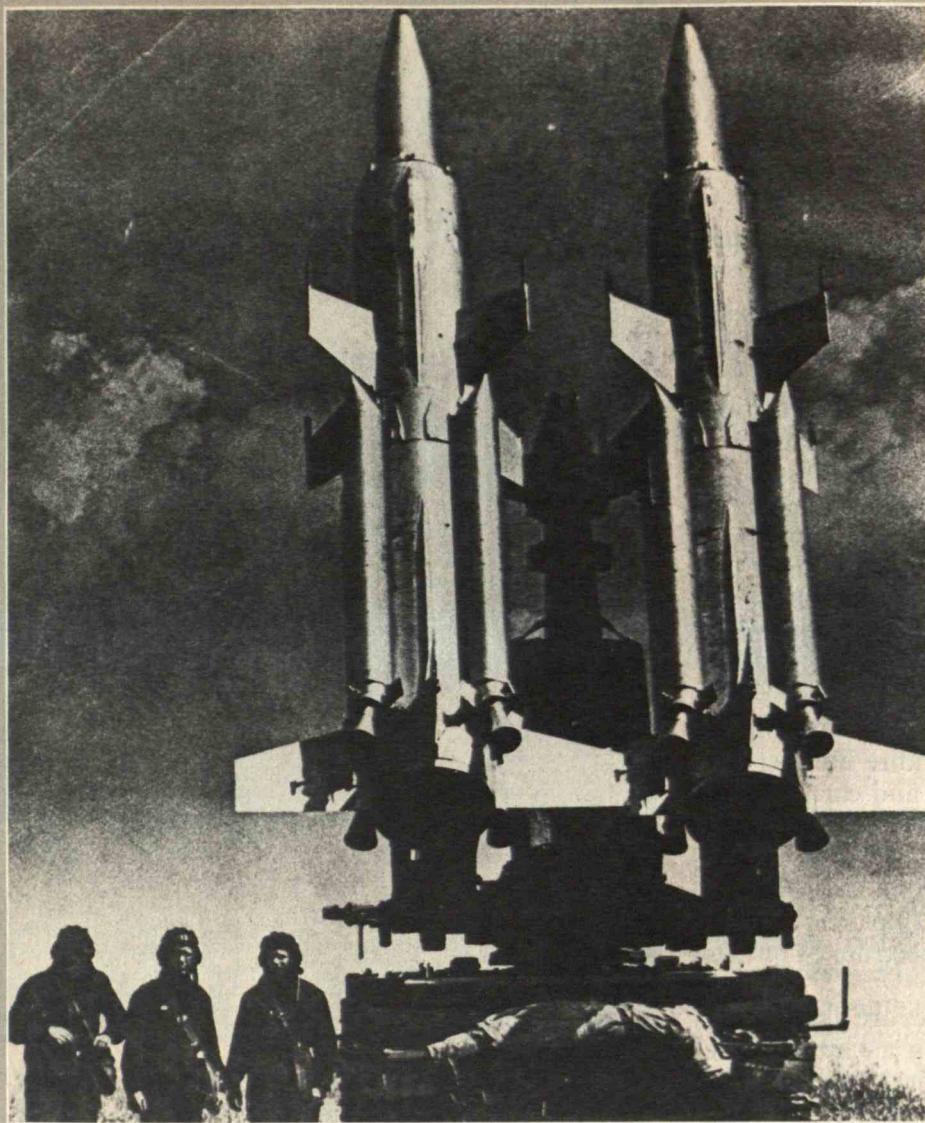


against missiles guided by lasers and millimeter waves than those guided by infrared. Thus, countermeasure technology is likely to lag behind new missile-sensor technology for the foreseeable future, with the relative cost-effectiveness of anti-tank warfare continuing to increase.

The tank enthusiast's adage that "the best anti-tank weapon is another tank" is no longer true. Just as the machine gun made the cavalry horse obsolete, modern anti-tank missiles have made the tank obsolete. The plain fact is that it is virtually impossible to hide some 60 tons of hot metal on the modern battlefield from the sensors of intelligent missiles.

Defending Combat Planes

Recent military conflicts point up the growing vulnerability of combat aircraft. During the Falklands War, 114 planes were shot down, the majority by smart missiles. More recently, the Israelis used air-



Left: Crewmen pose beside a Soviet SA-4 mobile air-defense system with missiles raised for launching. The weapons are used to shoot down low-flying aircraft. Other surface-to-air (SAM) missiles include the Swedish Bofors RB-70, the British Blowpipe and Rapier, and the American Stinger. Far left top: Syria defended its positions in Lebanon's Bekaa Valley with Soviet-made SAMs. Below left: U.S. Army personnel prepare a remotely piloted vehicle (RPV) for a test flight. For many military purposes, RPVs are more effective than manned aircraft.

to-air missiles to shoot down 90 Syrian warplanes during the war in Lebanon.

Both the United States and the Soviet Union are trying to make their planes less vulnerable to detection by enemy radar. The American B-1B strategic bomber, for example, is one tenth as visible to radar than its predecessor, the B-52. Military scientists are working on producing a warplane with even lower radar visibility—the so-called "stealth" bomber. Stealth will probably be achieved by a combination of shaping to reduce highly reflective angles, new radar-absorbing materials, and electronic jamming devices and other countermeasures. Stealth aircraft will not, of course, become completely invisible. They are also likely to be extremely expensive. For many if not all important military purposes, remotely piloted vehicles are far more cost-effective than manned aircraft.

RPVs could be used to launch air-to-air and air-to-surface missiles. Because there is no need to de-

fend a pilot, which requires a great deal of expensive electronic and other equipment, RPVs are relatively cheap. If we assume that an air attack on well-defended bombers would knock-out 20 percent of them, then 244 aircraft would be lost if 500 make three sorties. At \$25 million an aircraft, the loss would total more than \$6 billion. That money would buy more than 20,000 RPVs.

Can Warships Be Defended?

The U.S. Navy is making a major effort to develop a credible defense for its warships. To try to make their defenses more effective, U.S. warships normally sail the oceans in battle groups headed by an aircraft carrier. The group includes destroyers, cruisers, attack submarines, and logistical-support ships. The navy now operates 13 aircraft carriers and plans to increase that number to 15. It believes that it also needs 100 ships equipped with sophisticated anti-

aircraft weapons; some of these vessels will cost over \$1 billion.

Military planners recognize that anti-ship missiles are so effective that they can best be countered by detecting and attacking the enemy ships, submarines, and aircraft carrying them before they reach their launch positions. The navy's anti-air-warfare program is designed to intercept enemy bombers in an "outer zone" before U.S. ships come within range of their missiles. The "outer-zone" protection is provided by Hawkeye early-warning aircraft and F-14 Tomcat fighter interceptors, equipped with Phoenix air-to-air missiles. But because of the enormous range of Soviet maritime bombers, these defenses must cover huge areas of the world's oceans—so huge, in fact, that they are impossible to monitor fully. For example, the Soviet Backfire bomber has a range of some 5,000 kilometers and carries long-range supersonic AS-4 anti-ship missiles with a range of about 300 kilometers. Even if the warships escape air and submarine attack, they can be destroyed by missiles fired from Soviet surface ships. Of course, the United States offers a similar spectrum of threats to Soviet warships.

Therefore, many anti-ship missiles are likely to get through the outer-zone defenses in an attack. The U.S. Navy is trying to develop "area" defenses to attack the incoming missiles themselves at long range. This second layer of protection consists of long-range ship-to-air missiles carried aboard cruisers and destroyers equipped with the complex Aegis system. This system uses the most sophisticated technologies to detect and intercept high-speed cruise missiles at sea.

Anti-ship missiles that get through both the outer-zone and the area defenses are supposed to be attacked by "point" defenses at relatively short range. This third layer of defense includes short-range interceptor missiles and radar-controlled guns that fire 50 rounds a second.

Submarines pose another threat to warships. Modern submarines are so effective that, once again, the best way of neutralizing them is to attack them before they come within range. For this the U.S. Navy relies mainly on its own attack submarines and long-range P-3 patrol aircraft supported by undersea surveillance systems. The most effective weapon system for detecting and attacking enemy submarines is the hunter-killer submarine. The hunter-killer is usually a nuclear-powered sub equipped with sonar



Syrian tanks lay ruined in the Golan Heights during the 1973 Middle East War. Some 1,500 tanks were

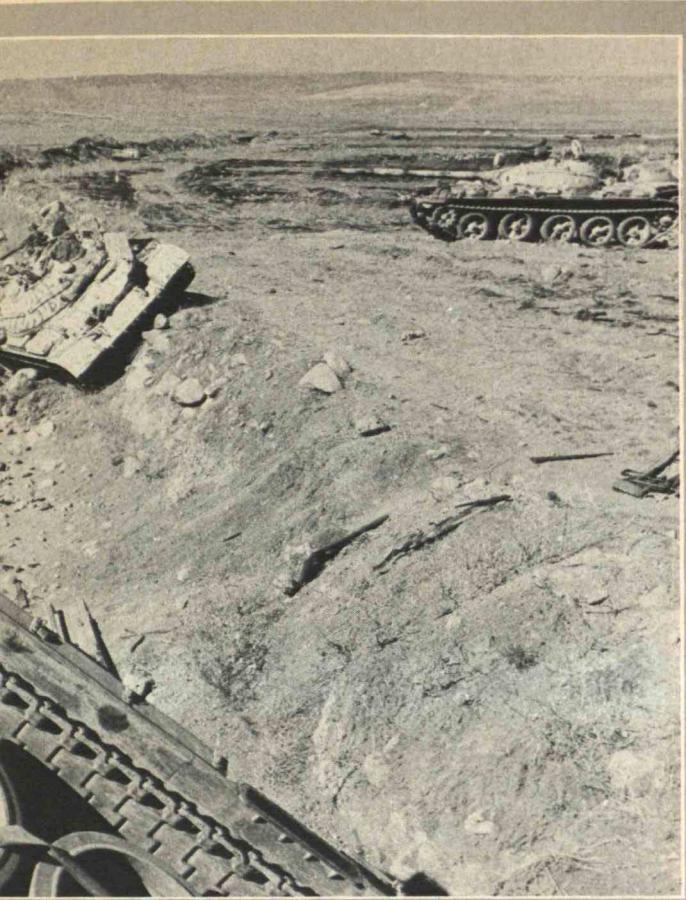
destroyed, many by anti-tank missiles. The tank enthusiast's adage that "the best anti-tank weapon is another tank"

and other sensors, underwater communications systems, and a computer to analyze data from the sensors and fire weapons. Hunter-killer submarines are very expensive: the U.S. Navy is paying about \$700 million for each. Nevertheless, it has 96 nuclear attack submarines and the Soviet Navy has about 65.

A significant fraction of the submarines attacking an American carrier battle group will evade the hunter-killers and the patrol planes. The carrier group will therefore use formations of surface ships carrying sonar systems and torpedo-armed helicopters for short-range protection. Anti-submarine warfare has become an exceedingly complicated and expensive operation.

But despite the enormous resources that the superpowers are investing in naval anti-air and anti-submarine systems, large warships are becoming increasingly vulnerable to anti-ship missile and submarine attack. Warships are also much more expensive than the weapon systems that can destroy them.

Given the vulnerability of large warships and the escalating costs of building them, why are the great powers still procuring them? Probably not for any



is no longer true. It is impossible to hide some 60 tons of hot metal from the sensors of today's intelligent missiles.

wartime use but to project power abroad in peacetime. In the words of U.S. Defense Secretary Caspar Weinberger, "Carrier battle groups, perhaps the most visible symbol of America's maritime capability, support our foreign policy through a series of routine overseas deployments." Both superpowers want to play this game. We must therefore expect the Soviet-American naval rivalry to continue.

Defensive Deterrence for NATO

As we have seen, new military technologies increasingly favor defense over offense. This has raised considerable interest in the concept of a "non-provocative" defense for European NATO countries. Such a strategy would be based on the principle that military forces can provide an effective defense while having virtually no offensive capability.

In Western Europe, a non-provocative, non-nuclear defense would look something like the following. A defense zone some 50 kilometers deep would be maintained all along the 1,000-kilometer East-West border. This zone would be saturated with all kinds of ground-based sensors, a vast network of

underground fiber-optic cables for secure communications, and positions for troops to take cover.

NATO could build many anti-tank obstacles in this area and seed it with smart anti-tank mines. These devices would delay enemy tanks and channel them into areas where they could be bombarded and destroyed.

The alliance could arm its troops with a judicious mixture of anti-tank missiles and cannons, anti-aircraft missiles, and light anti-aircraft guns. Emphasis would be given to simply operated and expendable missiles, cheap to produce in large quantities.

Mobile squads armed with weapons of high fire-power would be used to deal with enemy forces that broke through the forward defense zone. Troops dispersed throughout each NATO country would defend coastal areas and deter attacks by airborne forces.

The armed forces would not have main battle tanks, long-range combat aircraft, or large warships. Nor would they have long-range airlift capability. The ranges of missiles would be no more than required to bombard the defense zone—roughly 80 kilometers—and therefore they would not be provocative. Combat aircraft would be limited to single-role interceptors and close-support ground-attack aircraft. Naval forces would rely on missile-armed fast patrol boats equipped with anti-ship missiles and on small diesel-powered submarines, which are less expensive than their nuclear-powered counterparts.

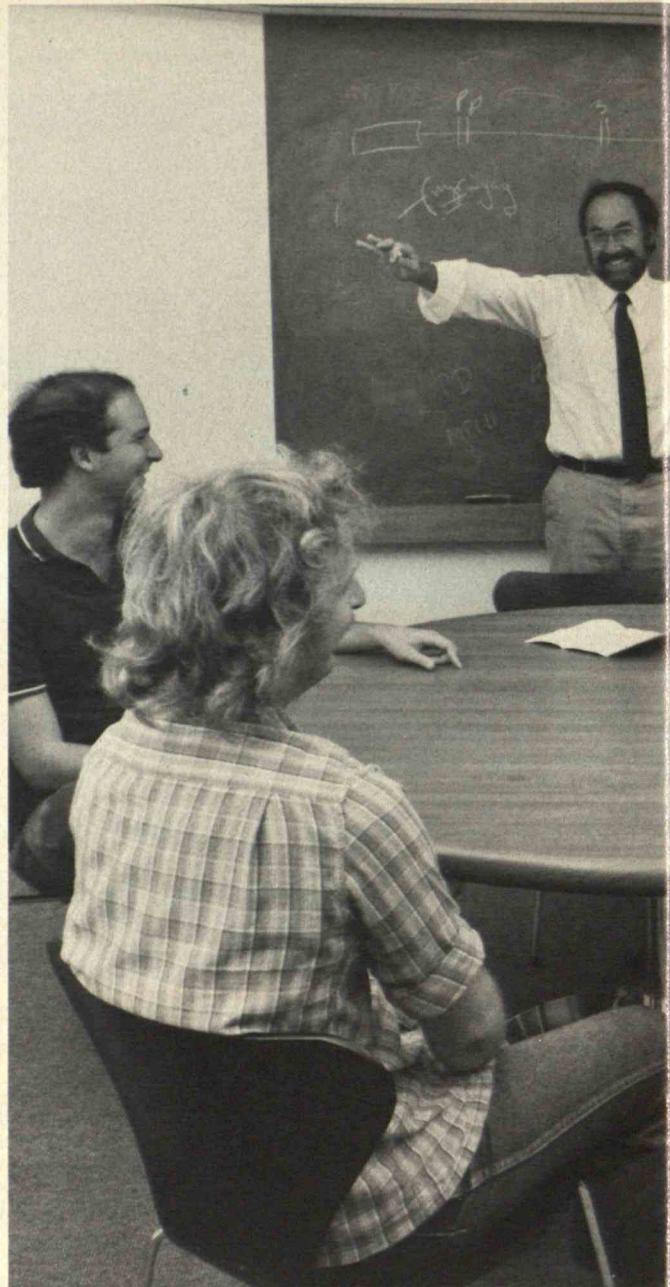
The alliance can use the new technologies to provide an effective deterrent based on non-nuclear weapons against an attack by Warsaw Pact forces. Of course, the West needs to be able to respond in kind to a Soviet nuclear attack, but that eventuality is not what NATO strategists are most concerned about. They worry about the Warsaw Pact tanks, aircraft, and troops that outnumber their Western counterparts. With the new defensive technologies, NATO could abandon its current policy of resorting to nuclear forces—and very likely escalating to all-out nuclear war—merely to defend against a large conventional attack by Soviet-bloc forces.

A conventional defensive deterrent would be consistent with the universally recognized right of self-defense and would therefore be morally acceptable and unambiguously legal. It would also be militarily credible. For these reasons, the people of Europe in general and the armed forces in particular should welcome it. □

David Baltimore: Setting the Record Straight on Biotechnology

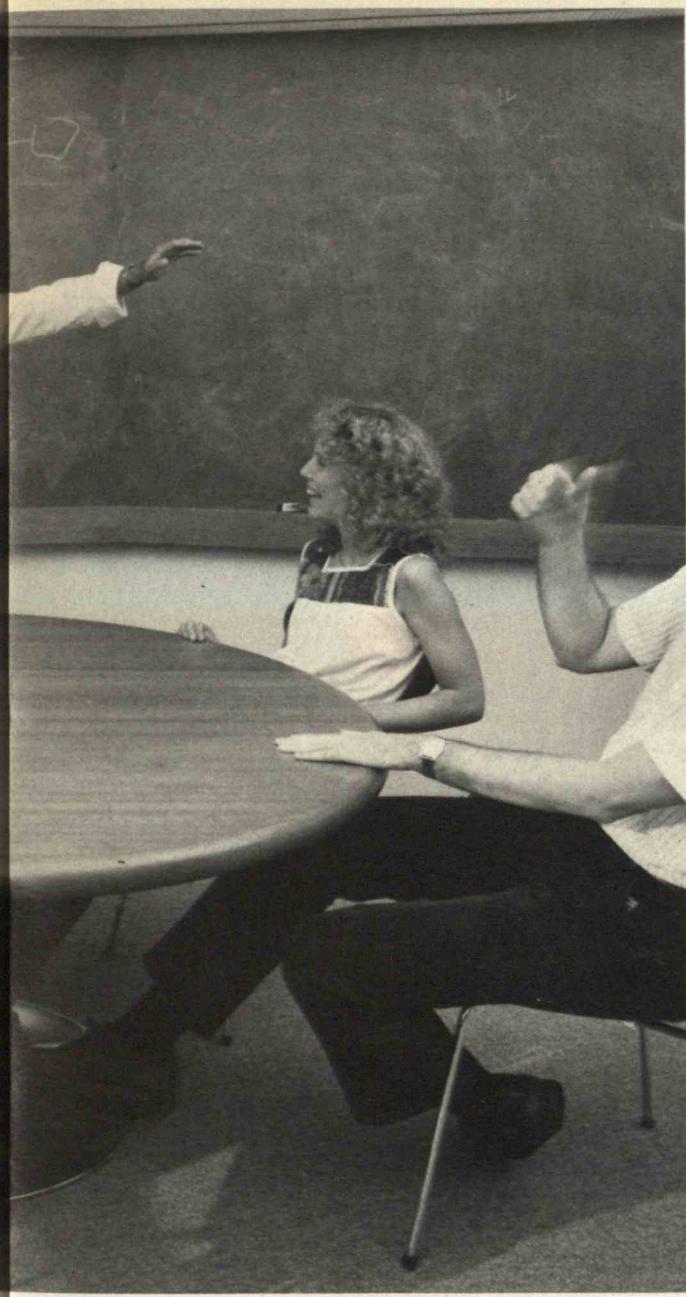
After a decade of fast-paced, competitive research, the long-awaited products of biotechnology are finally making their way into the marketplace. An artificial version of human growth hormone, created by genetic engineering, is being used to treat children with pituitary dwarfism, and genetically produced human insulin has been on the market since 1982. The Food and Drug Administration recently approved the use of the first human hepatitis vaccine made with recombinant DNA methods, and a number of companies have field-tested genetically altered bacteria for agricultural use. U.S. scientists are on the verge of conducting the first human gene-therapy experiments—replacing a defective gene with a normal one in the hopes of treating disease.

But a series of recent incidents seems to have clouded biotechnology's debut. Early last spring, Advanced Genetic Systems, a small biotechnology company, admitted that—without the approval of the Environmental Protection Agency (EPA)—it had field-tested bacteria that were genetically altered to protect plants from frost. Even though the company eventually received EPA approval to perform the tests, its admission aroused the indignation of local residents in Monterey, Calif., and forced EPA to suspend its permit. A few weeks later came the news that the U.S. Department of Agriculture had approved the testing of a genetically altered viral vaccine for livestock without consulting its own recombinant-DNA research committee. In the wake of these widely publicized incidents, the Reagan administration has released a set of new guidelines



for regulating biotechnology and its products. But public concerns remain about how this new industry and its potent technology will be controlled.

In this interview, Nobel laureate David Baltimore explains why many of these concerns are red herrings. Baltimore, who won the Nobel Prize in 1975 for clarifying the interaction between tumor viruses and cancer, earned his Ph.D. in molecular biology at Rockefeller University in 1964. He was one of the first scientists to question the safety of recombinant-DNA research in the early 1970s and call for public debate on the issue. He served as a member of the National Institutes of Health (NIH) Recombinant



Advisory Committee (RAC), the group of scientists that guided biotechnology research through its tumultuous early years. He is now professor of microbiology at M.I.T. and director of the Whitehead Institute for Biomedical Research, an independent basic-research center affiliated with M.I.T. Baltimore is also on the scientific board of Collaborative Research, a biotechnology company in which he owns stock.

Technology Review senior editor Alison Bass recently talked with Baltimore in his office at the Whitehead in Cambridge. An edited version of their conversation follows.

The Nobel laureate microbiologist explains why many of the issues raised by critics of biotechnology are false alarms.

TECHNOLOGY REVIEW: As demonstrated by the recent controversies over the field-testing of genetically altered organisms, biotechnology is an area of great concern. Do you think such concerns are valid?

BALTIMORE: I think genetic engineering in general is something people should be concerned about because molecular biology is extremely potent in what it can do. People ought to be aware of what's going on. However, the two genetically altered products receiving most of the publicity are very poor examples to be concerned about. Both the livestock viral vaccine and the frost-free bacteria are minimal forms of genetic manipulation that will not have a major effect on the environment. That's because the manipulation in both cases involves simply deleting a gene. In the bacteria, scientists deleted a gene that codes for the protein promoting ice formation on plants. Spraying that bacteria on certain crops will protect them against freezing at lower temperatures. In the pseudorabies livestock virus, scientists deleted a gene that makes a protein that apparently contributes to the virus's virulence. When the virus lacks this gene, it can no longer cause disease. It's safe to use as a vaccine strain.

Simple deletions like these occur all the time naturally, and if any one of them produced an organism better adapted to survival than the organism already existing, the mutant organism would have a selective advantage. It would by natural selection become dominant in the environment. So you don't have to worry about a simple deletion of a gene because it has probably already occurred in nature and has been proven not to have a selective advantage. For



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something to have a major effect on the environment, it has to have a selective advantage over other existing organisms.

TR: Are you saying this "ice-minus" bacteria already exists in nature?

BALTIMORE: Yes. For all intents and purposes, it does. We don't know that this deletion has occurred in nature in the sense that I can show it to you. We know it in the sense that simple deletions in DNA occur all the time; they occur in human beings.

TR: So why can't we use the mutant bacteria that already exist to protect crops from frost?

BALTIMORE: If there are a billion bacteria and one of them has this deletion and that deletion is not favored in nature in any way, how do you find it? You can't screen a billion organisms. Also, all mutants look alike. A mutation that involves the deletion of a single nucleotide base on the DNA strand that makes up a gene could function exactly like a deletion that involves a larger number of nucleotides: neither mutation will make the protein that promotes ice formation. So you can't tell the difference. Furthermore, you can't rely on a natural mutation that involves the change of a single DNA base: the probability is too strong that there will be another natural mutation in the descendants that reverts the gene back to the original structure. That's because one single-base mutation could inactivate the gene that makes the key protein, but the genetic sequence would still be there and subject to another mutation. However, if you snip the entire gene out through recombinant DNA methods, there isn't any chance of reversion.

TR: Does the altered pseudorabies virus exist in nature as well?

BALTIMORE: Yes. I'm 100 percent sure that a virus with the same thymidine kinase gene deleted in the engineered sequence could be found in nature. And it could be found much more easily than the frost-free bacteria because the genetics of this virus are much better known. I personally don't know why Saul Kit [the researcher who developed the strain]

didn't bother trying to find it. I think he was just being fancy and modern in employing recombinant-DNA techniques.

The point is that both these incidents are bad cases: they are cases that ought to be considered routine in a rational world. The problem is that the issues in this debate have been largely chosen by Jeremy Rifkin [a Washington attorney who is one of biotechnology's most vociferous critics]. But Rifkin doesn't bother to explain the facts about simple genetic deletions to the press. And the newspapers don't explain these things I'm saying either, so they make it appear there's been a flagrant disregard for public safety.

A Biological Fundamentalist

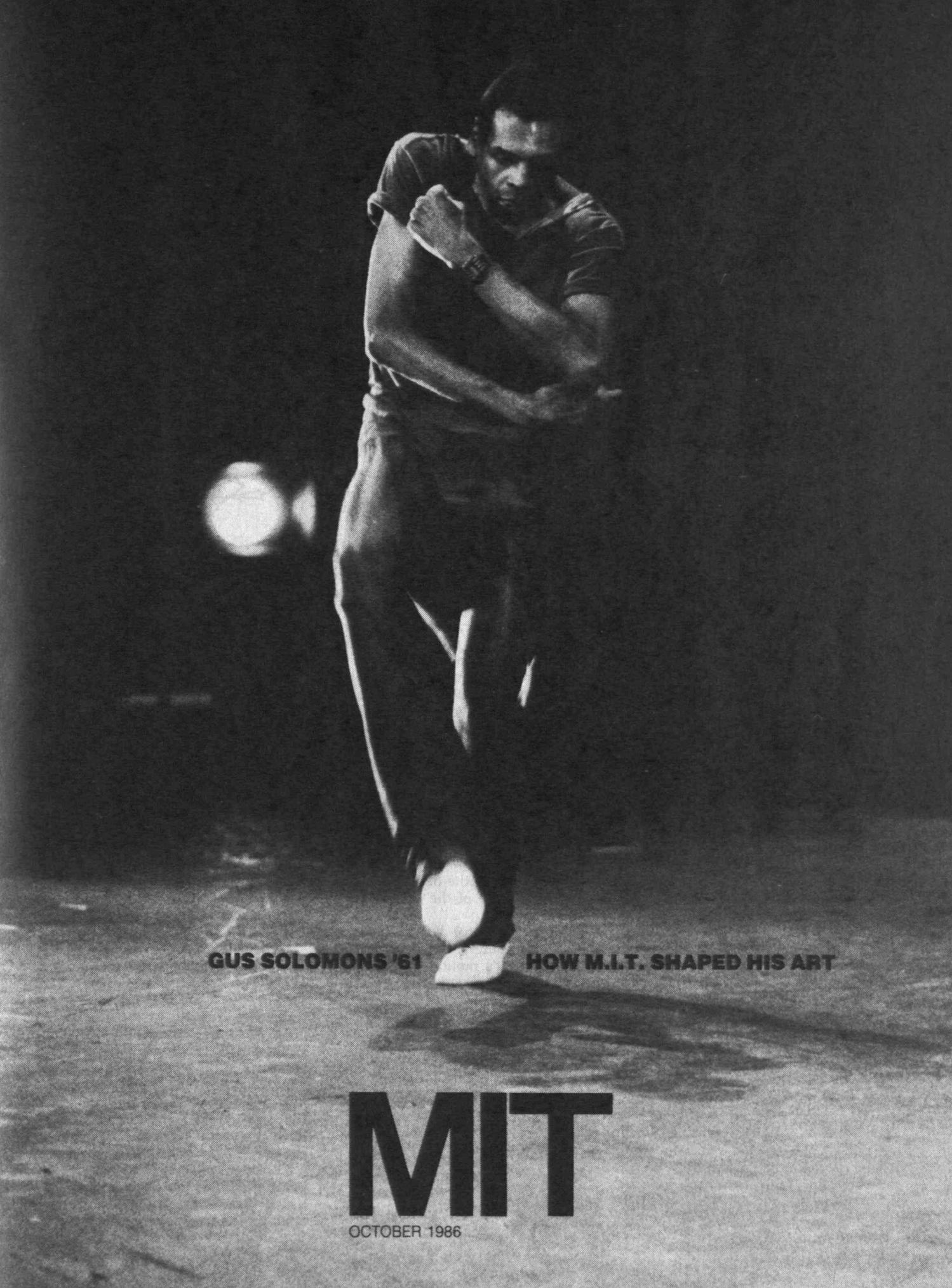
TR: If these particular organisms will have no detrimental ecological effects, then why is Jeremy Rifkin opposing their release in experimental field tests?

BALTIMORE: I think Rifkin is trying to stop everything that's going on in biotechnology. That's why he's focusing on trivial considerations instead of legitimate serious issues. As far as I'm concerned, Rifkin is in the same pot with religious fundamentalists who believe certain things should be done and certain things shouldn't be done. In his own way, Rifkin is a biological fundamentalist. And I don't see why the whole world has to frame the debate around his particular myopic views.

TR: But he seems to have given voice to the fears many people have about genetic engineering.

BALTIMORE: He certainly does manage to bring fears to the surface. And it's not that I doubt that the fears are either real or even justified. I've said for years that concern about modern biology is certainly appropriate, but I think that concern has to be tempered by some sense of realism.

TR: I wonder if he's effective because he's operating in a vacuum, because there are no other people who are voicing serious concerns.



GUS SOLOMONS '61

HOW M.I.T. SHAPED HIS ART

MIT

OCTOBER 1986

REUNIONS '86

How 2,000 alumni found joy in a Cambridge downpour

Intelligent television? Yes, it will know what to show you

Gus Solomons jr., '61: 25 years as architect of movement

WALLE NAUTA

The leader of a renaissance in neuroanatomy retires

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ABOUT THE COVER

When Gus Solomons jr., '61, left Boston 25 years ago no one thought an M.I.T. alumnus could make a living in ballet. But last June Solomons' dance company was the hit of reunion weekend. "All the principles I learned about design I use daily when I choreograph," Solomons told writer Debra Cash. (Photo: Frank Revi, '86)

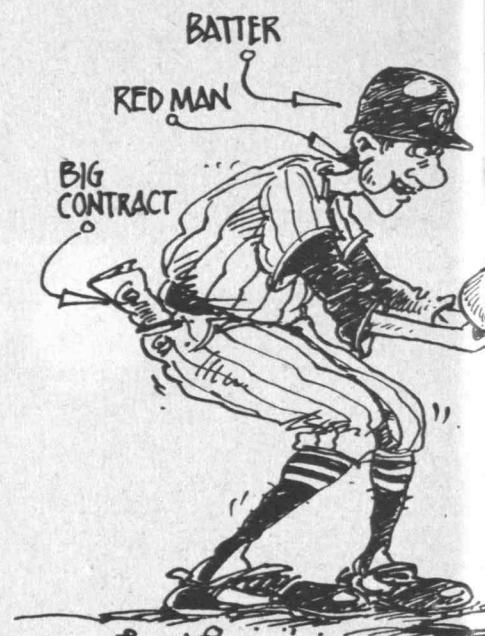
All Things Do Not Come to Those Who Wait!

When I was first learning to play baseball, I was a cautious fielder. I reasoned that if I watched the first bounce of a ball, the second would be much like the first, and I would be ready for it. Imagine my surprise when the second bounce often appeared lower and faster than the first. I know now that those grounders were my introduction to the importance of spin in following a bouncing ball—lessons that carry over to other sports such as tennis or squash.

A bounce, for the sake of clarity, is a collision between a moving spheroid (what we sports experts refer to as "the ball") and a large, usually immobile, surface such as the ground or wall. If you believe Sir Isaac, the changes in motion of the ball are the result of forces the surface exerts on the ball.

There are two forces at work here—the one perpendicular to the surface and the one along the surface. Consider the former: In an elastic bounce, as in the case of a superball, the perpendicular velocity of the ball is simply reversed, and a ball comes back up to virtually the height from which it was dropped. In most other cases, squash balls and the like, some of the ball's kinetic energy is lost in the process of bouncing, and it doesn't come up as high. If the perpendicular force were the only one to consider, the bounce of the ball would be fairly simple.

The frictional force along the surface complicates matters, however. Friction affects the ball's motion in a direction parallel to the surface, but it also exerts a torque that changes the rotation of the ball about its center. The perpendicular force, on the other hand, does not exert a torque, since its direction is along the radius of the ball (the cross product of r



and F is zero, for you vector freaks).

Let's look at a particular case. Imagine a baseball moving straight off a bat (to the right, in our illustration), bouncing off the ground. During the time of contact, the ground pushes on the ball in the opposite direction to the way the ball's point of contact is trying to move. This one idea is all you have to keep in mind.

If the ball isn't spinning, every point on the ball is trying to move to the right at the same speed, and the force is to the left. But a ball with a lot of topspin (clockwise rotation in the illustration) could have the point on the bottom actually moving to the left, and the ground will push to the right. A ball with backspin could have the contact point moving to the right faster than the rest of the ball. A sidespinning ball would have that point moving into or out of the page!

Consider what that means for the ball's spin after the bounce. A hit ball usually leaves the bat with very little spin; on the first bounce, the ground's



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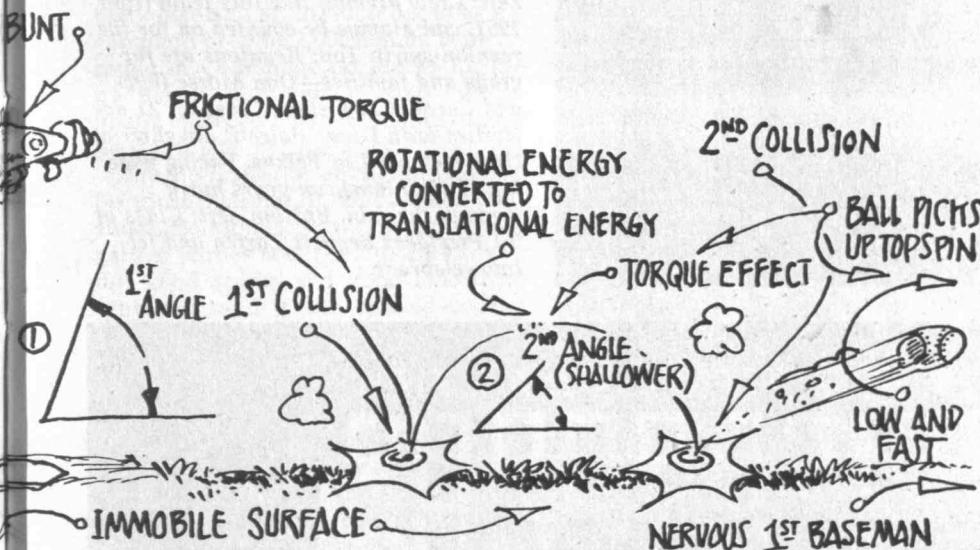
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push to the left gives it a topspin. A ball that initially has topspin or backspin will lose much of its spin, since the torque opposes the initial rotation.

Next, how does the initial spin of the ball affect its motion after the bounce? Remember, if a ball has no spin, it will bounce back up at about the same angle at which it came down. A backspinning ball, however, experiences a larger frictional force to the left than a ball with no spin, since that bottom point is moving to the right faster. That slows the ball down more, as well as making it come off at a steeper angle. A topspinning ball can actually gain speed on a bounce. In effect, some of its rotational energy is converted into translational energy (forward motion), and the ball bounces off faster and at a shallower angle. A more mathematical derivation of these results can be found in *American Journal of Physics*, 49, 356 (1981), for those of you who are into this sort of thing.

Determining the motion of a ball after a bounce is just a matter of thinking about the force at the point of contact,

taking into account the ball's spin. The strategy behind putting topspin or backspin on a tennis shot now becomes more apparent, as you can cause the ball to bounce in ways that make life difficult for your opponent. Spin adds a new dimension to any sport in which the ball hits a floor, backboard or walls.

I will close with two other examples. A basketball is often shot by allowing it to roll off of the fingers, giving it a natural backspin. If it hits the rim, the frictional force is larger, and the ball loses more of its energy. This keeps it from bouncing too far from the basket, and gives a higher likelihood that it will eventually drop through the hoop.

Finally, consider a hit in baseball: The ball comes off the bat with little spin, but it picks up topspin on the first bounce. This means that on the second bounce, the ball comes off lower and faster, terrorizing the hapless infielder. It has taken me a few years, but I finally understand why I only compounded my difficulties by letting the ball take a second bounce while I got "ready" for it! □

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Left: Crew alumni, like this team from 1951, can always be counted on for the reunion spirit. Top: Reunions are for grads and families—Don Morse (left) and Carole Clark share Class of '21 activities with Diane Balesti, daughter of class member Leo Pelkus. Facing page, top: T-Day luncheon-goers hurry through the rain. Bottom, left: Class of '61 President Bennett Zarren and fellow celebrant.



Dampened in Fact but Never in Spirit

Less than a week after they nearly routed Commencement (see *August/September*, pages MIT 4-9), the forces that control New England's fickle spring weather confounded M.I.T. festivity planners again. Rain began as the vanguard of some 2,000 alumni were arriving in Cambridge on June 5 for the traditional class reunions, and the sun finally emerged only after all had safely departed late on June 8.

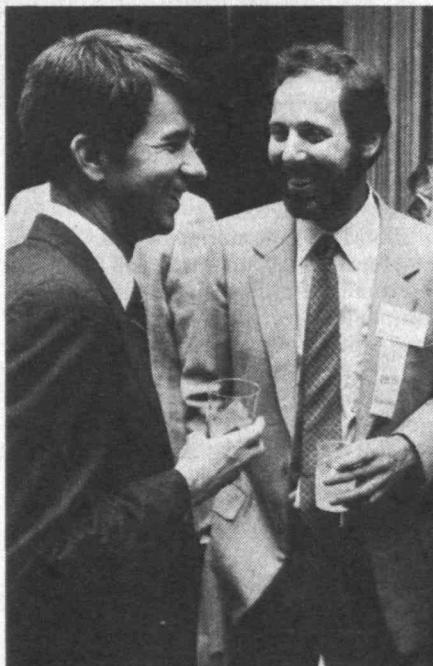
But the resilience of alumni is not to be underestimated. Feet were wet, shoes abandoned. Picnics were moved, garden parties convened under canvas. But good spirits and good fellowship prevailed, and it was proved conclusively that water is not a diluent for loyalty to alma mater or curiosity about its work.

The curiosity was satisfied, in part, on June 6 by a panel of experts on "TV and the Cinema of the Future." Their message in a nutshell: future visual media will be characterized by lively interactions with viewers. (For more details on this program, see the accompanying report by writer Barbara Bialick.)

The outstanding demonstration of loyalty came at the annual Technology Day luncheon when an audience of just over 1,000 heard a record \$12.1 million in reunion giving reported by seven of the quinquennial classes.

The M.I.T. spirit was everywhere during the weekend. Undeterred by rain and fog, 95 members of the Classes of 1976 and 1981 and their guests took to Massachusetts Bay for a whalewatch on Saturday morning. No whales—not a single sighting. Dismayed, Bay State Cruises gave everyone rainchecks. (It's been a lean year for whalewatchers: most of the animals that have recently spent the spring and summer off Boston were elsewhere last summer—no one knows where or why.)

Oarsmen, remembering early spring training on the Charles, were in their element in the drizzle-loaded east wind; both 1931 and 1951 had early-morning turnouts. A picnic for 215 members of the 25-year Class of 1961—complete with 500 frisbees—was moved from



Thompson's Island to the Athletic Center, where Guinness (if looking) might well have observed a new world record for frisbees per cubic foot of air space.

Dick Reedy, '51, and his wife Carol entertained Reedy's 35-year classmates for a clambake at their Gloucester ocean-front home with aplomb—providing two large tents and a squadron of portable heaters to dry the grass. The Nautical Association was not quite so fortunate: there was no way to shelter the sailors during a day of sailing to celebrate the sport's 50th anniversary at M.I.T., but events at the Sailing Pavilion went on regardless. And then there was the Class of 1981's effort to create the romance of the Hawaiian Islands in the West Campus picnic area that was the class's senior gift to M.I.T. five years ago. The elements pushed their Polynesian party into the Student Center.

Most alumni had generous praises for Joseph J. Martori, associate secretary of the Alumni Association who serves as concierge for the the quinquennial (every fifth year) reunions and Technology Day. Martori dips his hat, in turn, to Lucille A. O'Hehir and John T. McNeill, catering manager and operations manager, respectively, of the M.I.T. Food Services, who changed plans and moved food around the campus with apparent ease. Martori also saluted Eliza Dame, the coordinator of reunions, who only joined the Alumni Association in March, when preparations were already in high gear. Dame's grace under pressure bodes well for future reunions, Martori said.

As their secretaries report in this issue, classes travelling off the campus for their reunions—1956 to the golf courses and mansions of Newport, R.I.; 1946 to Stratton Mountain, Vermont; and 1936 and 1931 to Cape Cod—found the weather no friendlier but the fellowship just as warm, the beer just as cold.

"The Best Reward I've Ever Had"

Seventy-three different classes and nine different countries were represented at the Technology Day luncheon, with

Clockwise, from right: The Class of '66 on a tour of their old Boston haunts. Class of '36 President Alice Kimball with classmates. Newly-minted honorary member of the Alumni Association, Institute Professor Mildred Dresselhaus. And 30th Reunion Gift Chairman Ron Massa (left) congratulated by '56 Class President William Northfield.



1,050 alumni and their guests assembled beneath the class banners. Oldest among them were two members of the Class of 1913—Warren E. Glancy and Walter P. Muther; the farthest travelled was James O. Salveson, '51, from Jakarta, Indonesia.

The record for reunion giving went to the Class of 1936—a total of \$3,531,117. Louis E. Stahl, the 1936 reunion gift chairman, recalled a "dark and dismal world" that he and his classmates entered upon graduation—a world in which an M.I.T. diploma was "very special, a big advantage over everyone else." That memory, he said, was why a record 78 percent of the class had given to its 50-year fund "to help worthy and needy students get an education they otherwise couldn't afford." The same

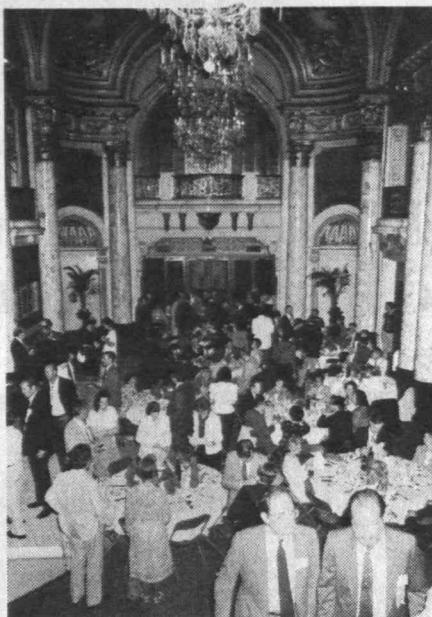
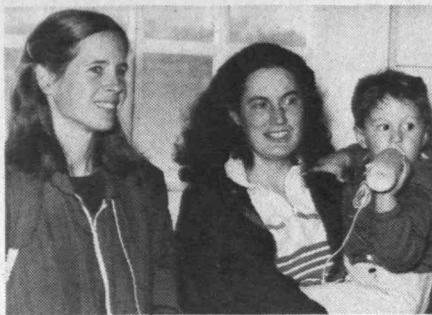
reason is why 26 members of the class report plans for future gifts (i.e., bequests) of \$2,178,000.

The M.I.T. memories of the Class of 1946 include calisthenics at 6 a.m. and the threat of military discharge that accompanied every failing grade. It was the Institute's second smallest wartime class; of more than 1,000 freshmen, only 256 remained to receive bachelor's degrees as seniors 32 months after entering. But the average grade on the Navy's final exam, recalled class president S. James Goldstein, was "the highest on record anywhere in the U.S. at any time—a powerful and irrefutable statement about the quality of an M.I.T. education." The pride of Goldstein's classmates was also reflected in the gift that he and Robert E. Spoerl reported—

\$1,359,656 from 68.6 percent of the class (a record for a 40th reunion), the work of a gift committee headed by Ernest U. Buckman, who couldn't be present.

It's worth noting that the gifts of "major" reunion classes—the 25th, 40th, and 50th—represent giving over the five years prior to the reunion and pledges covering the ensuing five years. For the 60th and 65th year class gifts, the preceding five years are counted. Other class gifts are assembled only during the year immediately before a quinquennial reunion.

Two records were set by the reunion gift of the Class of 1961, announced jointly by gift chairman Ira J. Jaffee and class president Bennett M. Zarren: \$2,174,094 was the largest 25-year gift ever, and it came from a record 71 per-



cent of the class. Of that total, \$440,000 was designated for a permanent endowment for student financial aid.

Then came a report from E. Milton Bevington, '49, Alumni Association president: to celebrate its 65th reunion, the Class of 1921 had raised a stunning total of \$3,205,000. ("Why not a 65th reunion gift?" chairman Samuel E. Lunden had asked four years ago, to start the ball rolling.) The announcement brought a general intake of breaths in the Athletic Center; wrote a classmate later, "That sound, which seemed to come from all over the hall, is the biggest and best reward I've ever had—one that more than repays all the time and effort of the last 65 years of serving M.I.T."

Other announcements: 78 percent of the surviving members of the Class of

1926 contributed \$2,400,347 to a 60th-reunion gift for which Millard M. Greer and I. Austin Kelly III were cochairmen. Thomas J. Martin, Jr., led the Class of 1976 to a \$35,000 tenth reunion gift; a fifth-reunion campaign led by Marc J. Chelemer and Jeffrey R. Solof stimulated gifts of \$18,000; and the Senior Class of 1986 gave a total of \$19,000, including a light sculpture by William P. Parker, '74. Substantial portions of all these gifts were designated for student financial aid.

This \$12.1 million for M.I.T. from reunion classes brought obvious delight to President Paul E. Gray, '54. But even more impressive, he said, was the extent of alumni participation that made the totals possible. Such results, he said, do not come about "by doing what comes

The revelry ranged from the banks of the Charles to the Grand Ballroom of the Ritz-Carleton Hotel. Clockwise, from top left: Kathy Jones, '71 (left) and Maria Bozzuto, '73, winners of the Collegiate Women's Sailing Championships in 1971, returned for the 50th anniversary of the Sailing Pavilion, which overlapped reunions this year. The Class of '61 held a dinner in a spectacular setting—The Boston Opera House. A subset of the Class of '51 posed for this quintessential reunion snapshot at their dinner-dance at the Ritz, an event that kept going when most alumni had packed it in for the night. The AA's new president, Joe Gavin, '41, in his first day on the job. Members of the Class of '13, Walter Muther (wearing impressive hearing aid) and Warren Glancy confer at the T-Day luncheon.

naturally. . . . One need not love a place less for having suffered in it," declared Gray, paraphrasing the famous phrase of Jane Austen.

Gray was singularly rewarded, he said, by hearing so much support for student financial aid. Scholarships and loans are needed by two-thirds of today's undergraduates, and to alumni who gave for this purpose, Gray paid particular tribute: "The future of this special place depends very much on you."

When introduced as 1986-87 president of the Alumni Association, Joseph G. Gavin, Jr., '41, promised that the association would launch "a national and international search for any who have not heard your message." —John Mattill □

Making Media Truly Interactive and Intensely Visual



Just before noon on June 6, all eyes in Kresge Auditorium were fixed on the screen, as a knight composed of multicolored shards came alive, lept from a stained-glass window, and terrorized an old Anglican priest.

It was a scene from *Young Sherlock Holmes*, and it marked the first time that a computer-generated figure interacted with a human on film without the source of the image being obvious.

But dazzling as this display of computer graphics was, it will be quite routine in the future, according to the panel of computer experts assembled for the Technology Day symposium on television and cinema.

The bottom line, emphasized moderator Nicholas Negroponte, '66, is that

communications media of every type will continue to become more and more interactive with the user. Negroponte, who is Jerome B. Wiesner Professor of Media and Technology, said that films and television will become so personalized that the user will not only choose when and where to watch news and entertainment programming, but will even have the option of changing or participating in the script.

There are already opportunities for viewers to exercise personal choice, Negroponte pointed out. "It used to be that going to the movies was more than the movie itself," he said. "You had to get the baby sitter, park the car." Then, of course, came the drive-in. But you were still subject to the film choices and

scheduling of the movie house, and similarly bound by the schedules and ratings fixations of the TV moguls.

Today, in contrast, technology in the form of VCR and pay cable is bringing movies into our homes. "This is the first year in history that rentals and purchases of videotapes (in the U.S.) will exceed the intake at the movie theaters, and TV itself is changing," Negroponte said. "There is no reason to look at TV when it's broadcast except for sports or elections," he maintains.

Negroponte anticipates a day when personal computers choose the most "appropriate" media to conform to what they "know" of their operators' individual tastes, lifestyles, and needs. Linked to an intelligent television, a computer

The day is coming when the home computer and family television will merge, and viewers can opt for programs of their own devising.

T-Day panelist Andrew Lippman used dramatic visuals to make his points about the work going on at M.I.T.'s Advanced TV Research Program. TV images that rival the quality of 35 mm film are available, he says, and squeezing feature films onto home-sized discs will make them cheap and convenient to watch.

will call to notify its user that "I just recorded 35 minutes of neat stuff for you," Negroponte said.

He even went so far as to hypothesize that in 10 or 20 years, there will be no channel knob on a TV—just dials for sex and violence. "Turn one up or down and you'll see a different program. . . . So if you turn down 'violence,' *The Equalizer* will only last a minute," Negroponte quipped.

Three Dimensions on a Flat Monitor?

What seemed especially evident in the sometimes astounding demonstrations was that we are entering a much more visual age. Computers will be able to create the illusion of three-dimensional images on a flat monitor. Sportscasts will lack only the smell of the ballpark, and reports of fires will be frighteningly real. Producers of this wizardry want nothing less than computer images so realistic as to be interchangeable with the genuine article.

Achieving such a standard will be no small feat, observed Alan Kay, whom Negroponte called the "father of personal computation." Kay, who is now scientist-at-large at Apple Computers, Inc., reported that representing animals realistically on the screen, for example, requires software so subtle it can account for the skeleton moving under the skin.

He showed an elaborate example from Muppet-maven Jim Henson's movie *Labyrinth*, in which every single feather on an owl had to be modeled separately so it would appear that air was flowing through the bird's plumage during flight. "It took 20,000 polygons for the

head alone," Kay pointed out.

Today, applications of available technology are greatly dependent on the whimsy of media creators such as Lucas Films, which made the movie *Star Trek II*. The T-Day audience was shown a scene that was remembered vividly by many: Mr. Spock brought back to life by the Genesis bomb, which was dropped on a dead planet and created new life out of the flames. But the Kresge showing came complete with commentary on the computer's role in the animated scenes.

Another company dedicated to graphics so perfect that the audience is unaware that the images are computer-generated is Pixar, Inc., a new offshoot of Lucas Films. The edges of computer-generated images tend to be jagged and the whole picture may be blurred—as anyone who plays with computer games already knows. Computer scientists at Pixar are trying to resolve these problems by working with random numbers and geometric shapes. To illustrate, Loren Carpenter, Pixar's senior scientist, showed a remarkably detailed rendition of a mountain that was created by breaking down large triangles into successively smaller ones.

In other applications, the same technology that made a knight leap out of a stained-glass window is also contributing to the refinement of nuclear magnetic resonance (NMR) as a medical diagnostic tool. This technology is used to show for example the beating of a patient's heart. Projects ranging from the geophysical analysis of the Gulf of Mexico to the design of automobiles—from chassis to paint scheme—are also increasingly based on sophisticated computer graphics.

Harrier Jump Jets to Sharks

There is unquestionably sharp interest in the educational possibilities of computer graphics, and Kay used this occasion to talk about a five-year pilot project in an inner-city school in Los Angeles. The project utilizes a version of Apple's military simulation program in

which the original Harrier jump jets are transformed into sharks to help students study the ocean environment. Not only can the children create sharks on the screen, but they can also design fantasy animals that never existed.

All these innovations notwithstanding, Kay said, "personal computing isn't even here yet. Portability is critical," he said. "It won't be a real tool until we can do mundane things with it, like put our grocery list on it and take it to the store." But that day is coming, all the panelists agreed.

When it does, the personal computer will be so tied to the household television set that they will be the same machine. What's more, M.I.T.'s Advanced TV Research Program is improving the quality of television images by increasing the efficiency with which the channels are used. Thus the number of lines in a TV picture can be increased, said Andrew Lippman, NEC Professor of Communications at M.I.T., and the images thus produced rival the quality found on a 35 mm. film. He speculated that "this might lead to a whole new field, electronic photography," with the still photographer upstaged by the artistry of high-quality video.

Eventually, said Lippman, feature-length films will be squeezed into standard home-sized discs. By then, he said, "movies will be so cheap, you'll just be paying for the right to watch them." But even with this freedom, he said, "We'll probably continue to go to the movie theater forever . . . until we can invent a sticky substance for our living room floors."

Is the computer revolution in the media an historical imperative? Lippman and the other panelists suspect so. "We have the potential to change our news and information systems," he said. "We can become programmers as we read." Who knows, perhaps viewers will turn off broadcast TV altogether in favor of producing their own extravaganzas.—Barbara Bialick □

BARBARA BIALICK is a Cambridge-based freelance writer.

Architect of Movement, Integrator of Body and Mind

Editor's note: Pumping adrenalin from their record-breaking success as fund raisers for the Institute, the Class of '61 swung into a blockbuster 25th Reunion. A high point was an elegant dinner served in the gently faded opulence of the Boston Opera House, where even the ladies' lounge is scaled to allow every woman enough floor space for an antebellum hooped gown.

The evening was further enriched when the class and their guests adjourned to the auditorium of the Opera House for a command performance by their classmate Gus Solomons jr (the form of his name that Solomon prefers) and members of his New York-based dance company.

In a medium where age is the ultimate enemy, where all one's inventiveness, experience, and artistic intensity can't compensate once the body has lost the stamina and aesthetic lines required, Solomons at age 46 is not just a choreographer and company director who occasionally dances. He is the vital centerpiece of the ensemble. His technical competence had to impress even those of his classmates who have a minimum interest in modern dance. And for the dance buffs in the group, the whole performance was a delight; they clustered around to hear him talk about his work at the end.

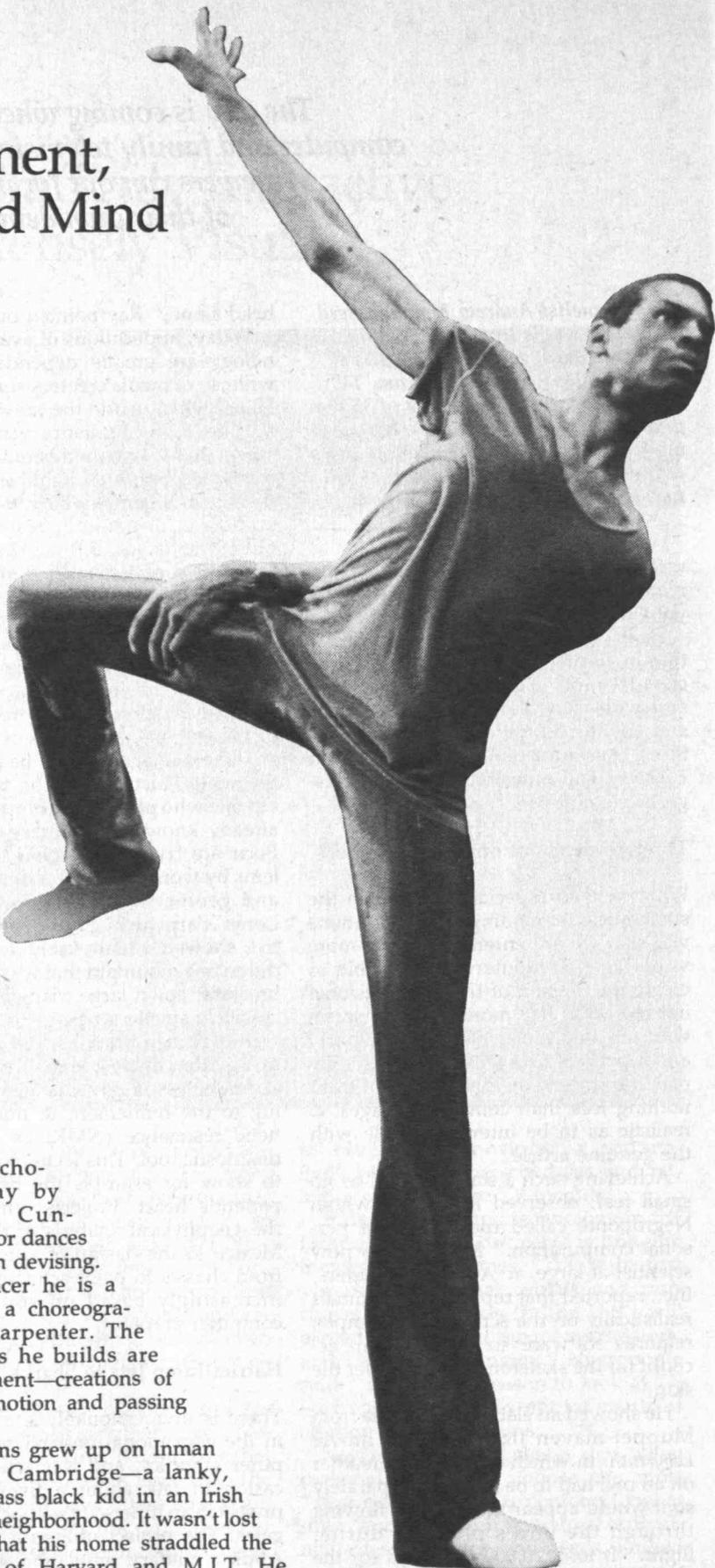
"He was in every theatrical event that happened on campus when I was here," remembered one alumnus. "Dramashop staged a production of Othello because Gus was available for the lead. But I never realized he was a member of my class."

To get a perspective on Solomons' place as an artist, the Review asked DEBRA CASH, a dance critic for the Boston Globe, to write the short profile that follows. Like Solomons, Cash is a site visitor for the National Endowment for the Arts Dance Panel.

Although Gus Solomons jr., '61, studied architecture at M.I.T., he has never built a house or designed an office building. The closest he came was a six-month stint as an interior decorator. But echoes of his background still reverberate in his career as a dancer. With his wiry 6'4" frame, Solomons sometimes looks like an animated step ladder, leaning across the placid linear

grids of choreography by Merce Cunningham or dances of his own devising. As a dancer he is a beam; as a choreographer, a carpenter. The structures he builds are impermanent—creations of shifting motion and passing time.

Solomons grew up on Inman Street in Cambridge—a lanky, middle-class black kid in an Irish Catholic neighborhood. It wasn't lost on him that his home straddled the shadows of Harvard and M.I.T. He



Gus Solomons' M.I.T. degree did not determine his career, but it certainly had an influence on his art.

graduated as valedictorian of his class at Cambridge High and Latin, and there wasn't much question that he would go to college. More puzzling was what he would study.

"I decided that architecture was the degree with the least reading," he laughs now. "And by my second year I led at least two lives." During the day his M.I.T. course work spanned fine arts to principles of mechanical engineering—"I flunked Heating and Ventilation (2.661)," he confesses. "I was so intimidated by all the physics they were throwing at us, I couldn't pass until I figured out that it was plumbing, not science. All I had to learn was how big the pipe had to be to carry a certain amount of air!" At night the self-declared "Mister Artsy Craftsy" crossed the Charles to sweat through dance classes at the Boston Conservatory of Music. "I fulfilled my humanities requirement with Tech Shows and Drama shop," he remembers with evi-

dent amusement. "All I had to read was my own part."

Solomons was still unsure that show business could be any way for an M.I.T. grad to make a living when, a few weeks after graduation, he was hired by choreographer Donald McKayle to dance in the Broadway-bound *Kicks and Company!* "It was a flop—it closed in Chicago," Solomons says. But he liked what he learned of the dancer's life, so he headed for New York, where his talent opened the doors in the companies of Martha Graham, Merce Cunningham, and the late Joyce Trisler. "I didn't make a living because I was rehearsing eight hours a day and you didn't get paid for rehearsals. (With the staggering cost of studio and living space in New York), you have to work much harder not to make a living these days!"

"All the principles I learned about design by studying architecture I use daily when I choreograph," Solomons says now. "My early works were all about structural principles and physical design." It's no surprise that these predilections would draw him to Cunningham's atomistic structures, where the bridges and arches made of body parts could be appreciated in terms of mass and weight and formal purity. "Now, as I get more comfortable with motion, my own work has become less linear and more kinesthetic."

But Solomons can wax poetic about the rooms in which his works are performed. This December, an evening-long work will have its New York premier at the refurbished Saint Mark's Church in the East Village. "The space is a golden rectangle," he says, explaining to someone who didn't study architecture that the proscenium space is perfectly divisible into its square and rectangular components; the proportions spiral like the chambers of a nautilus. "That proportion is like the



1-3-5 chord in music: it's organically pleasant to see. The waves of the spatial dimensions of the church will dictate the dimensions of the dance. I carry that savvy about how physical phenomena affect people from my architectural training.

"I'm more interested in physical principles than in human relations," he says. Even in his recent *Con/Texts*, which begins with a personal monologue, he announces, tongue in cheek, his refusal to talk about the "food or sex or dreams" that some younger choreographers seem to want to spill into the consciousness of the audience. "And I still love puzzles and logic problems. That has gotten me into trouble. People say my work is cold, intellectual, and I constantly have to justify why I haven't embraced the 'black' Alvin Ailey aesthetic."

Ironic, articulate, with a healthy sense of the ridiculous, Solomons is a regular on conference panels. He also makes funding recommendations as a site visitor for the Dance Panel of the National Endowment for the Arts. He has published dance criticism, and his writing occasionally appears in the *Village Voice*. "Writing," he says "is like building. I like putting words together and being able to shade things by the way I place the adjective." The kid who found reading an agony finds himself with pen in hand.

The five-man-and-one-woman Solomons Dance Company has toured widely and has been on the program at Massachusetts' summer dance mecca, Jacob's Pillow. But their center remains New York, where they have performances planned for both November and December. "I'm overexposing myself in New York City this fall," Solomons remarks, "but every once in a while you need to say, 'Here I am folks. I'm still here; I'm still doing it. Nyah, Nyah.' "—Debra Cash □





Walle Nauta, Surveyor of the Human Brain

"There is a time for coming and a time for going," Institute Professor Walle J.H. Nauta told an audience of students, colleagues, and friends in perhaps his last official lecture. "Since there is nothing to follow, for me, this is much like dessert."

The address by the 70-year-old Nauta was the finale of a symposium honoring him on the occasion of his retirement from M.I.T., where he's been a professor of neuroanatomy since 1964 and an Institute Professor since 1973. "I have a secret," he confessed to an audience that regarded him with esteem and affection. "I have been looking forward to this occasion, the occasion being that it doesn't make a whole lot of difference anymore whether I make sense scientifically or not. I'm not jeopardizing my next NIH grant application by sounding insane or, even worse than that, meaningless."

Were he meaningless, it would have been a first. Nauta is one of the world's leading experts on brain anatomy. A former president of the Society for Neuroscience, a member of the National Academy of Sciences and many other honorary societies, he has won numerous awards, including the F.O. Schmitt Medal and Prize in Neuroscience. He has authored nearly 120 publications, culminating with his landmark 1985 text, *Fundamental Neuroanatomy*, written with journalist (and former *Technology Review* staff editor) Michael Feirtag, '72.

Nauta was born in Indonesia and educated in Holland. He taught at the Universities of Utrecht, Leiden, and Zurich before starting research at the Walter Reed Army Institute in 1951. He also taught anatomy at the University of Maryland, before joining the faculty of M.I.T.'s Department of Psychology.

Nauta was first attracted to the brain while studying psychiatry as a medical student. "I became overawed by all the things the brain is capable of and saw how many disorders are affected by it," he said.

"I chose anatomy simply because I had little difficulty with spatial relationships—anatomy being a spatial form of science. In school I realized, 'Hey, these



other guys are having a hell of a time. I'm not having too much trouble. In fact, I find it rather enjoyable."

One of Nauta's biggest contributions, the so-called "Nauta method," was developed in the late 1940s, early 1950s. It offered a relatively simple way to trace nerve fibers through the brain and spinal cord. Techniques for staining these fibers had been available before Nauta, but they were comparatively slow and difficult to use. By experimenting with various silver solutions, Nauta was able to develop a stain that highlighted only those fibers of particular interest.

"Before Nauta came along, neuroanatomy was a real pain," said Edward Koh, an assistant professor at Tufts Medical School, who worked at Nauta's lab from 1975 to 1981. "He made fiber tracing available to the common man. He made it reliable enough, and easy enough, so that pretty much anyone could do it. It was really a liberating thing."

The introduction of the technique, according to Koh, was like the invention of a new microscope or telescope. "It

Walle Nauta's recent work involved using modern tracing techniques to highlight certain groups of neurons (such as these shown) that communicate directly with each other, in a sample of brain tissue containing millions of interconnected neurons.

allowed people to see things they couldn't see before. Until then, the big schools of neuroanatomy made all kinds of claims that were difficult to refute, because the results were so difficult to duplicate. The Nauta technique was a big step towards making neuroanatomy a science."

W. Maxwell Cowen, vice-president of the Salk Institute, credited Nauta's method with having "triggered the most astonishing renaissance in the history of neuroanatomy."

Nauta's staining method was improved in the late 1960s by Robert Fink and Leonard Heimer, then working in Nauta's M.I.T. lab. The Fink-Heimer technique made it easier to distinguish between nerve fibers passing through a specific region and those actually terminating there.

The improvements introduced by Nauta, Fink, and Heimer took some of the guesswork out of neuroscience, and also some of the artistry. "Now any fool can do it," Nauta reportedly joked.

Nauta applied his method and subsequent refinements to detailed studies of connections between various structures in the nervous system. He was among the first to investigate and classify parts of the brain by finding out what other parts they "talk to," or communicate with.

"You might say what I've been doing has resulted in road maps or wiring diagrams," he said. "Neuroanatomy is

Cambridge freelance writer STEVE NADIS specializes in neuroanatomy, botany, space art, nuclear war, volleyball, and the intimate connection between swimming and music.

Nauta Era Ends But His Legacy Lives at M.I.T.

Every scientific field has eras, and all of us who've studied the brain talk about the Nauta era," said Ann Graybiel, Ph.D.'71, M.I.T. professor of neuroanatomy. It was an era, according to Graybiel, that began in the late 1940s, and spinoffs from it continue to this day. As a tribute to her mentor, Professor Walee J.H. Nauta, Graybiel organized the symposium, "Frontiers in Neuroscience," held at the Institute in May of this year.

Graybiel encountered several difficulties while putting together the program. First she had to figure out "what of all Nauta has done should be emphasized. Here's a man who's worked on nearly every part of the brain."

A further problem, she said, "was trying to develop a symposium that Dr. Nauta would actually attend!" He had already told his wife, who informed his colleagues, that he didn't want anything done to celebrate his 70th birthday.

"I'm very familiar with his life's work, so I tried to build the meeting around the areas he's most interested in," Graybiel said. She invited the top specialists in the field, many of whom studied under Nauta, to present the latest techniques in neuroanatomy. This might have been risky, Graybiel noted, because many of these new techniques have in fact replaced methods pioneered by Nauta. But Nauta was always more concerned with discovery than with maintaining his control over the research process. "Besides, he uses the new techniques himself," she said.

The two-day symposium also explored another of Nauta's chief concerns, the higher functions of the human brain, including cognition and memory. The concluded with a lecture by Nauta on similarities between thought and motion.

Colleagues from across the country and Europe came to the symposium to pay their respects. At a banquet honoring Nauta, Francis O. Schmitt, professor emeritus whose vision led the Department of Biology to become a center for molecular and genetic science,

proposed a toast "to the 'tutor laureate' of neuroscience." Hans Kuypers, the professor of anatomy at Cambridge University, offered another toast to "the last father I have left." Edward Koh, now an assistant professor at Tufts Medical School, also acknowledged the "powerful influence" Nauta had on him. "I adopted him as my second father," Koh said.

Referring to Nauta's unflappable modesty, Graybiel said, "Those of you who've spent some time at M.I.T. have probably long since stopped believing that the meek shall inherit the earth . . . except in Dr. Nauta's case."

With Nauta's retirement, Graybiel has taken over his neuroscience course at M.I.T. and at the Harvard Medical School. While the emphasis under Nauta had been on tracing nerve pathways in the brain, work in Graybiel's lab focuses more on neurotransmitters, brain chemistry, and the human (as opposed to animal) brain.

The shift in focus is one of which Nauta heartily approves. "Neuroanatomy, physiology, and pharmacology are complementary strategies," he said. "These days it's hard to keep them separate."

In related research elsewhere in the Institute, Gerald Schneider, Ph.D.'66, heads a laboratory that investigates the development of nervous systems, the brain's response to injury, and regeneration of damaged nerve fibers. Schneider was trained by Nauta and is now a professor of neuroscience.

Over the past 40 years, Nauta has left his mark on hundreds of graduate students, postdoctoral fellows, and scientists throughout the world.

"Those of us fortunate enough to have worked with Nauta found it a magical experience," said Christiana Leonard, Ph.D.'67, an associate professor of neuroscience at the University of Florida Medical College. "He always divined the secrets of the universe. He made you feel that you were a partner with him in pushing back the frontiers of knowledge." —Steve Nadis □

really a naive first approach. It will never give you an exhaustive answer, only initial indications."

He compared it to the old story about the children of Coronado, the Spanish explorer. The sons set off from Florida in search of gold. They returned after two years without finding any gold, but they did locate a promising place in which to look for it.

"That is pretty much the function of anatomy. You find certain relationships from which certain fanciful likelihoods emerge. It takes other disciplines like neurophysiology or neuropharmacology to find the real nuggets. Anatomy can only say, 'Let me advise you to look in this particular area.' "

One area Nauta has explored in detail is the limbic system, a set of structures in the forebrain thought to be related to mood, emotion, motivation, and memory, and its connections with the hypothalamus, the part of the brain that regulates the endocrine glands and other internal functions such as digestion, respiration, and circulation.

Nauta uncovered previously unrecognized links between the hypothalamus and the limbic system, reinforcing his view that the internal bodily state is profoundly influenced by emotions and thought processes. To make this point, he noted that probably everyone has said, at some time or another, "Just the thought of that makes me ill." Nauta found a physical basis for this phenomenon.

By tracing nerve pathways, he also discovered that the limbic system extends farther down into the brain than was previously realized and includes structures in the midbrain and stem.

I'm In Favor of Vague Terms."

Despite his contributions, the limbic system remains a rather mysterious concept, criticized by some for being too vague. "I'm all in favor of vague terms," Nauta responded. They offer "real advantages."

As an example, he pointed to the basal ganglia, a massive structure in the ce-

*Nauta's work
points to hitherto unproven links
between emotions and
bodily functions.*



rebral hemisphere that is involved in motor functions. Basal ganglia translates to: "gray masses of neurons at the base of the brain." "I prefer the term 'basal ganglia' to something like the 'central motor system,' because we still don't know all of its functions," he said.

Another area of interest for Nauta has been the so-called "higher functions" or cognitive functions associated with the frontal lobe. People with damaged fron-

tal lobes have difficulty planning or thinking about the future. They may engage in erratic behavior such as urinating in the middle of business meetings or cancelling insurance policies. In fact, during an anatomy lecture at M.I.T., Nauta explained that the insurance industry was dependent on healthy frontal lobes. "Those two skyscrapers across the river," he said, pointing to the John Hancock and Prudential buildings, "are

Walle Nauta was treated to three days of high-level neuroanatomy discussions and festivities with colleagues from around the world. (Clockwise from top left) Enrique Ramon-Molinar of the University of Sherbrooke in Canada pours champagne for Nauta and Eva-Marie Ritter-Walker, an administrator in Applied Biological Sciences at M.I.T.; Nauta admires a framed poster of the "Schmoo-brain," his renowned teaching device; a warm exchange between Nauta and Konrad Akert, president of the University of Zurich; and symposium speaker Francis Crick, of DNA fame, uses a convenient blackboard to make a point.

really built on the soft tissue of the frontal lobe."

About five years ago, while waiting in the airport terminal, Nauta absent-mindedly watched the people pass by. Suddenly, he was jolted by the realization that he had forgotten to bring his slides of brain specimens. "This, to an anatomist, is a total catastrophe, the point of no return," he said. "You shift

Continued on page MIT 36

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Grad Imprisoned Without Charge in Sri Lanka



The most riveting bulletin board in the Infinite Corridor over the summer was the one with a stylized image, cut from black paper, of a man hanging upside down, his wrists and ankles tightly bound.

The figure was repeated several times in a display assembled by the friends of Ramanujam Manikkalingam, '85, who has been held without charge in police custody in his native Sri Lanka since late March, and who reported to his mother—when she was finally allowed to see him—that he had been beaten with weighted plastic pipes while hanging upside down from a rafter.

The surrounding display was austere, concentrating on two grim aspects of the case: the abuses Ram has suffered since he was arrested under Sri Lanka's Prevention of Terrorism Act, and the seeming imperviousness of the Sri Lanka government to international demands that Ram be allowed to defend himself against formal charges or released. The hanging figure, however, had a very emotional impact. It was meant to. Only by keeping concern for Ram intense and active can his family and friends hope

to have any effect on his situation.

Ram was a member of Alpha Delta Phi fraternity and worked at the Center for Space Research while earning a physics degree at M.I.T. A member of the Hindu Tamil ethnic minority in Sri Lanka, a country ruled by a Buddhist Sinhalese majority, Ram chose to return to his homeland shortly after his graduation. Once known primarily for its lush and beautiful geography, Sri Lanka is now distinctive for increasing separatist violence and the intensity of government pressure on even moderate Tamils.

It was March 28 of this year when Ram was abducted near his home, outside the capital city of Colombo, by a group of men in civilian clothes. He was hustled to a police facility, beaten, kicked, then confined incommunicado for weeks—deprived of medical attention, with his ankles chained to a wall.

For several weeks, the police denied any knowledge of his whereabouts. They finally announced on April 18 that he had been arrested far from Colombo, in an area contested by separatists and the scene of terrorist violence. The police subsequently claimed that Ram was as-

A visit of the Sri Lankan prime minister to Cambridge in July prompted a campus demonstration on behalf of Ramanujam Manikalingham, '85 (right), reportedly tortured while in police custody in his homeland.



sociated with a Marxist separatist group, that he played a part in smuggling weapons and explosives, and that he was involved in robberies designed to fund terrorist activities.

Ram was finally allowed to see his family and lawyer, and his case was scheduled for the first of a series of hearings before a board that had the power to recommend his release or continued incarceration. Over a period of months, hearings have been cancelled and rescheduled, the police have consistently failed to produce the required documents to enable the judiciary to proceed, and they usually fail even to produce Ram himself—no explanations offered. As of publication, he still had not been formally charged with any crime, although the statements about his alleged terrorist activities continue.

Mobilizing International Support

As news of Ram's arrest reached the Boston area, his friends, fraternity brothers, and colleagues at the Center for Space Research began making inquiries. By May, some 4,000 communications had been addressed to Sri Lankan and U.S. authorities on Ram's behalf. Senators Edward Kennedy and John Kerry sent joint letters to the President of Sri Lanka and the U.S. Secretary of State, and Amnesty International took up Ram's case.

Then in July the M.I.T. community had an opportunity to make a very direct appeal to the Prime Minister of Sri Lanka, Ranasinghe Premadasa. The Prime Minister had been invited to serve as the keynote speaker for a conference to be held at M.I.T. in the summer of 1986 under the auspices of the School of Architecture and Planning. The conference focused on design and housing in developing countries, an area in which Premadasa has notable expertise. (He has had a leading role in initiating his country's Million Houses Program and in organizing the United Nations International Year of Shelter for the Homeless in 1987.)

The Friends of Ram, a loose-knit coalition of his advocates, planned a demonstration, a news conference, and a rally to coincide with Premadasa's visit. Although the Prime Minister's speech was moved for security reasons to Endicott House, M.I.T.'s conference facility in Dedham, the demonstrations went ahead on campus.

More importantly, President Paul E. Gray, '54, and Dean of Architecture John de Monchaux arranged to meet with Premadasa specifically to outline their concerns for Ram's well-being and legal rights. Premadasa agreed to relay a document from Ram's lawyer to the appropriate authorities in Sri Lanka and to keep M.I.T. informed of progress in Ram's case.

Kathryn Fischbach, a graduate student in the Center for Space Research and a leader in the Friends of Ram, noted that the demonstration in Cambridge was given remarkable coverage

in the Sri Lankan media. It was the feature item on that night's television news and made headlines in all the island's major newspapers, it was reported to Fischbach, although the Sri Lankan media made every attempt to discredit the demonstration. Subsequent government response has been to deny Ram access to his lawyer.

The latest communication from the U.S. State Department, in response to a letter about Ram's case from Kenneth Campbell, director of the M.I.T. News Office, reports that Ram is seeing his family weekly, is not being mistreated, but (as of mid-September) is still in legal limbo. Since Ram is not an American citizen, notes the State Department, their "ability to intervene on his behalf is inherently limited."

That may be true, but Ram's friends do not plan to reduce their efforts. They remain convinced that the international spotlight is his best defense. □

This Is Official, Take Note!

The Board of Directors of the Alumni Association (AA) is in the process of updating the association's constitution. The document is more than 20 years old and doesn't adequately reflect, for example, the current geographic spread of alumni nor many of the successful new AA activities.

The directors will have a proposal for a revised constitution ready to circulate to all alumni along with the annual ballot in the spring of 1987.

The first step in the updating process is streamlining the procedures for revising the bylaws. At present, a cumbersome 30-to-90-days notice to all members is required before any board vote on bylaw change. A new Article IX, as stated below, will facilitate change, and will be voted on at

the December meeting of the board.

Any questions or comments on the new Article IX should be referred to AA President Joe Gavin, '41 or Executive Vice-President William Hecht, '61, through the Alumni Center, room 10-112.

(PROPOSED) ARTICLE IX AMMENDMENTS

The Bylaws may be amended at any meeting of the Board of Directors by a three-quarters vote of the full membership of the Board of Directors, provided that such full membership is notified in writing by the President, the Executive Vice President, the Secretary, or any three or more Directors acting together, of the proposed amendment at least twenty (20) days prior of such meeting.

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My dear '15ers, guess I have been completely letting you down. I have had a job which has been very demanding. Even though I have failed to report in *Tech Review*, I have been thinking about you!

Fred Vogel wrote a marvelous note to the Alumni Association, expressing his pleasure on being remembered by the Association on his 93rd birthday. Guess he is like all the rest of us as he mentioned finding it hard keeping everything up-to-date. Fred has been busy, as his wife was not well, but he cared for her a long time at home and then followed with continuous visitations to the nursing home where she needed more attention than it was possible to give her at home and was saddened when he lost her about a year ago. However, he is still up and at it, and must be complimented on his beautiful handwriting! **Bob Warren**, when talking to me on the phone, stated he had had a visit with Fred Vogel on the phone, and said how enjoyable it was to get the latest news from each other; so, if possible, '15ers, give your old classmate a call.

I myself intend to be writing to each one of you. As always, if you can write me a note, it will be a delight to have your tidings.

Francis Hann wrote to me recently, complimenting me on being your "hard working secretary." (I love it!) My only regret is that I do not have as much time to spend on the keeping in touch with you folks as I would like, but rest assured, will try to improve! Francis is still very active and stated he tires sooner than usual, but rests and sleeps well and generally feels happy.

I talked to **Mimi Plummer Rice** on the phone and except for knee problems she is fantastic, playing bridge whenever possible and is happy with her living quarters. She is the second oldest co-ed, her sister-in-law being the oldest. . . . **Bob Warren** attended Alumni Day in June. Mary Kyger and Joe Recchio, from the Alumni Office, went out to Weston and picked up Bob, as always gave him the full gracious treatment for the day, and delivered him home in the late afternoon. Bob has his summer place at Buzzards Bay where he will have a family reunion.

I have had tidings from the alumni office, as well as from Rita Witek, who was a neighbor of **George J. Easter**, that he has passed away. George was a prominent ceramics engineer, and worked at the Ferro Corp. as research and development chief from 1947 to 1963, and then was a consultant afterward until he retired in 1974. Earlier he was a research and development manager for Carborundum of Niagara Falls for 27 years. He held some 60 U.S. and foreign patents on refractories and abrasives, and was author of the section on refractories for *Collier's Encyclopedia* and the section on abrasives for *Peoples Encyclopedia and the Encyclopedia of Chemistry*. The National Institute of Ceramic Engineers honored him for distinguished service in 1966 by presenting him its Greaves-Walker Award. He is listed in editions of *American Men of Science*, *Who's Who in Engineering*, and *Who's Who in New York*.

Now for my exciting piece of news. This morning I was listening to WBZ on the radio from Boston, and a lady called and asked Norman Nathan, the host on the talk program, for the words of "Life's Railway to Heaven." Immediately I perked up my ears, as I have done this hymn as a solo in church. When I finally got through to the station, I first told about my association with M.I.T., how I had received an honorary membership to the Alumni Association, and how my life had been so enriched by being associated with my wonderful '15ers and the Alumni Association acquaintances. I feel so very fortunate for this privilege. Norman Nathan was very glad to learn about 1915 the Class Supreme! I ended my conversation with Norman by singing part of the first stanza of "Life's Railway to Heaven." How about that?

That's all for now, '15ers. Keep in touch!—
Joyce E. Brado, Class Agent, 491 Davison Rd., Apt. 9, Lockport, NY 14094

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We enjoyed our 70th reunion luncheon on Technology Day at M.I.T. Attending the luncheon were **Izzy Richmond** with his wife, Anne, and his daughter, Jean; **Chet Richardson** with two daughters, Jane and Ruth; **Dan Comiskey**, Sibyl L. (Mrs. Ralph) Fletcher, and Rose and **Bob O'Brien**. It was nice to be together again.

Joel Connolly recently wrote, "I am unable to attend the 70th but hope to attend the 75th and see the beaches of New England again. My travelling days are over now. Having circled the globe five times, I guess I've had my share of travel. Since my wife died, I live alone. Every day a helper comes to cook, clean house, and do all for me that is necessary. I get to the Calalina Rotary Club lunch every Friday and to church service every Sunday. My doctor does not let me drive a car. A fellow Rotarian takes me to and from Rotary meetings. Just now I have in my yard pink and red hollyhocks ten feet tall and filled with blossoms to the very top—beautiful!"

Elbridge Devine writes, "At this time in my life, it is news just to be up and around. Many years ago I heard a man ask, 'What should be considered a successful career, not riches or fame but what?' On my mantel, I have a four-generations picture of male Devines all having the name Elbridge some place in their name. My father also was an Elbridge, but he does not appear in that picture. When I look at that picture, I say, 'Well, you have been a success!' I do manage to work in my yard on flowers and vegetables. I have some thing growing in my yard from March (crocus) to October (flax)."

John Fairfield missed the 70th. He writes: "I'd love to attend the 70th reunion, but the going seems too formidable, and staying home and helping spring beauty along is too attractive . . . pruning, weeding, planting, and pausing to see the flowers, hear the birds and bees, talk with the dog, and ruminate on the durable satisfactions of life. What are they? I read once that anyone who reaches the age of 60 without having been jailed

or bankrupted can count himself a success in life (a quite minute test but satisfactory for a minimum). Of course, one counts health (and at 90 coping with existence is a triumph), family, friends, classmates, colleagues, and memories of successes, triumphs, and efforts. My best regards to those who can get to Boston for the reunion."

From Charles "Mac" McCarthy: "I regret that I will not be able to join you on this festive occasion which marks the 70th reunion year of the class of 1916. I am in no immediate danger of departing from this world but have to contend with a heart condition which requires medication and places a restriction on my activities. Please extend my greetings and best wishes to the classmates who come to the luncheon."

Jean Richmond pleased us with the following highlights of her father's career. **Isidor "Izzy" Richmond** is the winner of a number of awards for excellence in architectural design. Among these awards are, in 1949, the J. Harleston Parker Medal for Temple Emeth, the South Brookline Community Center; the American Institute of Architects Medal of Honor for the Brookline Incinerator; and, in 1923, the Rotch Travelling Scholarship. Winning the Rotch Travelling Scholarship provided him with the opportunity to study at the Ecole des Beaux Arts in Paris and the American Academy in Rome. After his study in Europe, Mr. Richmond returned to his alma mater to become an instructor in architectural design. He returned to Europe after World War I to participate on a reconstruction team in France. There he created the drawings to rebuild a church in Rheims.

In addition to design awards, Mr. Richmond held a number of offices in architectural organizations. He both held the office of president and taught at the Boston Architectural Center. From 1953-1955, he was president of the Boston Society of Architects. He was elected to fellowship in the American Institute of Architects, and he served on a commission to preserve the historical and artistic integrity of Beacon Hill.

Although watercolor painting and pencil sketching are hobbies, Mr. Richmond is an artist of some note. In 1955, he won a prize at the Boston Arts Festival for one of his pencil sketches. As early as 1908, when his ninth grade class in Beachmont went outside to witness a flight demonstration by Lincoln Beechey, he developed a fascination for flying. He was able to realize his ambition to fly when he won his wings in the naval air force during World War I. Again in World War II, he held the rank of commander with responsibility for the naval air base in Bahia, Brazil. After the war, he continued flying as a civilian until well into his seventies.

Because Mr. Richmond believes in speaking the language of the countries in which he lives, he speaks five languages. One of these, Spanish, he actually learned by accident. Before he went to Bahia, he learned Spanish, only to find out when he arrived that he had to learn Portuguese to communicate in that city.

Just before the 70th reunion luncheon, **Al Niebecker** called from his home in South Pasadena,

Calif. At the age of 96, he is able to get around nicely with a walker. He has four children in the area who are attentive to his needs. He indicated that he attended M.I.T. for one year to get his degree in architecture and remembered so well that it was **Izzy Richmond** who took him under his wing and helped him get acquainted with the city of Boston. Al wanted Izzy to know that he also was made a fellow of the American Institute of Architects.

'They are still favorite sweethearts after 62 years together.' That's the caption from a newspaper clipping sent to us by **Dan Comiskey** describing the wonderful life that he and Grace have shared. Here are portions of that article. 'They first fell in love at Needham High School, where they both graduated with the class of 1911. They met at a football party, and Daniel was first attracted to Grace Comiskey because she danced so well. They often went dancing, especially liked to waltz. . . . Daniel delighted the Health Club Center staff one day last week when he put on his red coat with the M.I.T. emblem on the pocket and the M.I.T. buttons. He was heading out to his 70th class reunion. 'I missed the first 25, but I have been to almost every one since,' he said.'

We regret to report the passing of two of our beloved classmates. Dr. **Paul Duff** died in June 1986. His widow, Francine, will be comforted in this time of great loss by their 10 children, 43 grandchildren and, 7 great-grandchildren. Paul and Frances attended practically all of our class reunions over the last 35 years, and Paul always had beautifully humorous stories to tell us at the Saturday night dinners. . . . **Theodore Parsons** died in April 1986 after a long illness. His daughter kindly notified us. May their souls rest in peace. Please keep writing, keep smiling, keep healthy, keep breathing.—**Bob O'Brien**, Acting Secretary, 28 Marinell Ave., No. Chelmsford, MA 01863

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Warren Seamans, M.I.T. Museum director, and Phyl and Don Severance, '38, see **Stan Dunning** occasionally in New Hampshire. And **Ray Brooks** keeps up his M.I.T. contacts by telephone and notes to Hugh Darden and Don. We are grateful to Don for forwarding the following class of '17 news to the *Review*.

Word has been received of the death of Jeanette (Mrs. **Stan**) **Dunning** on March 15, 1986, after a long illness at the Havenwood Retirement Community in Concord, N.H. She attended many of the class reunions and will be remembered for her joyous enthusiasm. Our sympathy is extended to Mr. Dunning, who continues to live at Havenwood and is visited occasionally by Don and Phyl, Warren, and friends from the Skating Club of Boston, to which he belonged and with whom he skated for a number of years.

Ray Brooks reports that he is very busy and very happy in this year of his 91st birthday. He is still living in his comfortable Summit, N.J., home. Hugh and Don can confirm that he continues to

have piles of unanswered correspondence from friends and others fascinated with aviation and the primitive (by our standards) planes of the World War I era.

Thanks to many flying friends, he manages to fly all over the country. Recently, one of his close friends flew him to the Fighter Pilots Association meeting in Los Angeles for a great four days with Jimmy Doolittle and his wife Jo, Bob Hope, Jimmy Stewart, and others. Incidentally, Jimmy Doolittle and Ray have been friends for decades.

A couple of years ago, the Severances photographed Ray's World War I plane at the Garber Restoration Center of the Smithsonian Air and Space Museum. The years had taken their toll, especially on the fabric covering. Now, after two years' work, it's in cream puff condition, ready for its camouflage to be reconstructed.

Class members will be receiving a letter from the Alumni Association asking for suggestions on the 70th reunion next June. A good response is hoped for along with some notes of your activities.—ed. (Walter J. Beadle, Secretary, Kendal at Longwood, Box 217, Kennett Square, PA 19348)

18

News from classmates is at a minimum as is apt to be the case at this time of the year. Your secretary visited the M.I.T. Museum recently and was particularly impressed with the exhibit of photographs by the late Ansel Adams. I wish it would be possible for you to see this show and the many other subjects on view there. A bit of nostalgia was the picture of classmate Professor **Carleton Tucker**, who was responsible more than anyone else for the M.I.T. telephone system.

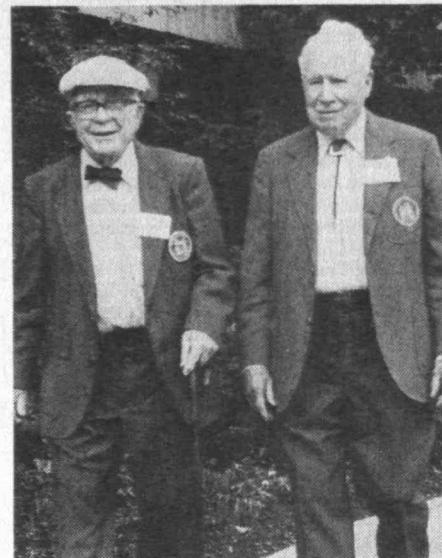
A recent happy occasion for Selma (Smith, '19) and me was a visit to the Smith College Museum of Art to view an exhibition of European and Early American primitives. The 26 paintings, including ones by William Matthew Prior and T. Chambers, are on permanent loan to the museum from our personal collection, ultimately to become a gift to Smith College Museum of Art.

Bill Hecht, executive vice-president of the Alumni Association, sent a warm letter reporting the receipt of \$6,000 to the M.I.T. Alumni Fund from the Washington, D.C., Seminar Series. He noted that this Washington Club activity was inspired by the success of the Boston Seminar Series, which yours truly helped to start a little over ten years ago.

We record with sympathy the passing of **Douglas Buchanan**, no details available.—**Max Seltzer**, Secretary, 865 Central Ave., Needham, MA 02192; **Leonard I. Levine**, Assistant Secretary, 599 Washington St., Brookline, MA 02176

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We regret to report the deaths of two of our classmates. **Walter C. Roberts** of Weymouth, Mass., died on December 3, 1985 at a local nursing home. Walter was born in Berwick, Maine, 88 years ago and settled in Weymouth in 1922 where



The spirit of comradery of the 2,000 alumni who attended M.I.T.'s 1986 reunion festivities last June 5-7 was exemplified by the class of 1921. (Above, left: Frank Whelan; right: Class Secretary Sumner Hayward).

Undaunted by the inclement weather, the 65th reunion of the class was a "grand" success, with a turnout of 18 alumni and 10 guests, more than had been expected. Highlights of the weekend included a visit to the Dedham Historical Society Museum, Technology Day Luncheon with the presentation of the class gift, and the banquet at the Braeburn Country Club. Much gratitude for the splendid arrangements went to Reunion Chairman Don Morse and his committee.

he remained the rest of his life. He worked for the former East Braintree Finishing Co. and retired after 40 years. He was the husband of Margaret (Wieden) Roberts. He is survived by three sons, three daughters, thirteen grandchildren and eight great grandchildren. The Alumni Office received a letter from **Vincent Williams** of Tegucigalpa, Honduras, which I quote. 'With a lot of sorrow, I inform you that my beloved father, Abraham Williams, '19, died in this city on March 24, 1986.'

We recently had a pleasant chat on the telephone with **Don Way** and his wife Barbara and were glad to find them both well. Until next issue.—**W.A. Langille**, Secretary, Box 144, Gladstone, NJ 07934

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Technology Day representatives of the class were **Pat and Buzz Burroughs**, **Kay and Frank Maconi**, **Al Burke** and **Elbridge Wason**. The report is that rain failed to dampen the spirits of those in attendance. Your secretary had hoped to be there but was prevented by a temporary disability.

It is with sadness that I report the untimely death of our good friend and classmate, **Henry Hills** on April 22. Henry was the victim of an automobile accident in Norwood, Mass. A lifetime

resident of Melrose, he made his winter home at 49 Melrose St. and spent the summer season at La Jolla, Calif. He was vice-president of Jackson and Moreland for many years and acted as a consultant to the Boston Edison Co. He was a former director of the Eastern Gas and Fuel Associates, a member of the Engineer's Club, and Algonquin Club and the National Association of Engineers. He was a navy veteran of World War II. He is survived by his wife Mary, a son, and two grandchildren. A faithful attendant at class reunions he will be remembered for his hearty chuckle and warm friendship with a host of classmates. We shall miss him.

Carleton Proctor died on January 19. He lived in Reading, Mass., and is survived by a son.

I am indebted to **Elbridge Wason** for information about his family ties with M.I.T. Elbridge's father, Leonard C. Wason, was class of '91 at M.I.T. Hence, there has been a member of the Wason family connected with M.I.T. for almost 100 years. It is interesting to speculate as to whether any other family can boast of this record.—**Harold Bugbee**, Secretary, Apt. 702, Country Club Heights, 3 Rehabilitation Way, Woburn, MA 01801

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Our 65th was a grand reunion! The reunion committee, chaired by **Don Morse**, did a wonderful job. Eighteen classmates attended with ten guests—more than we had expected. Those attending were Onie and **Elliot Adams**, **Sumner Hayward**, **Leila and Samuel Lunden**, **Donald McGuire**, **Robert Miller**, **Leo Pelkins** and his daughter **Diane Balestri**, **Henry Taintor**, **Maxine and Carole Clarke**, **Mary and Benjamin Fisher**, **Edmund MacDonald**, **Donald Morse**, **Marion and Sumner Schein**, **Whitney Wetherell**, **Alex and Munroe Hawes** and granddaughter **Dawn Fredericks**, **Irving Jakobson**, **Helga and James Parsons**, **William Sherry**, **Madeline (Mrs. Ralph) Shaw** and **Frank Whelan**. Most stayed at the Hyatt Hotel but five men stayed at McCormick Hall. We arrived in Cambridge on June 4 and class activities started the next morning. The tour bus took us to the Dedham Historical Society Museum where we had an interesting tour. Don Morse is an active benefactor of the Society. An excellent lunch with wine was served at M.I.T.'s Endicott House and it was easy to understand why other classes had found the Endicott House a fine place for reunion headquarters. The pre-Pops buffet and Technology Night at the Pops were fun and enhanced by the red heart-shaped balloons M.I.T. 1921 sent to us by the Clarke's daughter Ellie, and much in evidence at the Pops. Friday morning a number of us attended the Chapel memorial service where the list of 1921 deaths was soberingly long. The morning program in Kresge Auditorium was excellent and our later attendance at the *Technology Review*'s sherry party was fun. At the Technology Day luncheon, our class gift of over \$3 million for the past five years was the second largest of all reunion classes. Hurrah! At 6:00 p.m. that day the bus took us up to the Braeburn Country Club for cocktails and class banquet hosted by the generosity of Ed MacDonald and Don Morse. It was a grand finale. Guests were Anne and John Mattill of *Technology Review* and Dr. and Mrs. Irwin Sizer. Dr. Sizer gave a brief talk. At the business meeting the current class officers were nominated and elected for another five-year term. A motion by your secretary-treasurer to turn over our class funds to M.I.T. was defeated. So endeth a grand reunion. Our thanks go out to Don Morse and his reunion committee for a fine job.

We missed seeing Graciela and **Helier Rodriguez** whose health did not permit their coming; Ruth (Mrs. Irving) Jakobson, also for health reasons; and **Helen St. Laurent** who had recently had eye surgery.

Letters received in June from Claudia (Mrs. Josiah) Crosby and Helier Rodriguez mentioned

that Helier drove down to Sarasota and stopped in for a brief surprise visit with Claudia. She has gone to Maine for the summer. Claudia wrote and **Herb Kaufmann** confirmed that the Kaufmanns are moving into a retirement home at Lakehouse East #261, 4540 Bee Ridge Rd., Sarasota, FL 33583.

An Alumni Fund envelope from Cac Clarke mentioned that he was the only surviving one of six founders of the M.I.T. Club of Northern N.J. He is a past president of that club, and also served at one time as secretary of the M.I.T. Club of Montreal, and as executive vice president of the M.I.T. Club of Mexico City. He has also served as the first class agent of our class and as secretary-treasurer, vice president and now president.

Three deaths are reported this month: **Donald F. Lyman**, St. Petersburg, Fla. on February 9, 1986; **Robert L. Moore**, Concord, Mass., on April 23, 1986; **Edmund G. Farrand**, Del Mar Calif., in May, 1986. Robert Moore was a co-founder of the Sheraton Hotels Corp. He served in World War I as an ambulance driver and as an aviator with the French Air Service. He was shot down in a combat mission but managed to fly back across No Mans Land to safety. He was awarded the French Croix de Guerre. Moore attended Harvard, Class of 1918, and in World War II, Moore joined with his friend William Lear in producing the Radio Direction Finder used in all U.S. military aircraft.

Edmund Farrand was our class agent since 1943, a loyal alumnus of M.I.T. At one time he was the owner of the Farrands Farms in Georgia with 1,400 head of cattle. Ed served as executive vice president of the Leesburg Chamber of Commerce and as the president of the Lee County Farm Bureau. In those days, his principal hobby was horses—riding, racing, polo.—**Sumner Hayward**, Secretary; Wellspring House E64, Washington Ave. Ext., Albany, NY 12203; **Samuel E. Lunden**, Assistant Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

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Class members at the meetings in Kresge and at the luncheon in the Athletic Center on Technology Day were **Marjorie Pierce**, **Oscar Horovitz**, **Walter Saunders**, **Charles Hall Baker** and your secretary. Marjorie, now class treasurer, reports \$4,000 plus in the bank. Provost John Deutch has thoughtfully supplied the class officers with a copy of the final report of Philip S. Khoury, associate professor of history, recounting his activities over the last two years as the Class of 1922 Career Development Professor. During his tenure, Professor Khoury was able to pursue two different research projects in his area of specialization, the modern history and politics of the Middle East. The first project was the completion of a major narrative history of the Syrian national independence movement between the two world wars. This study will be published this fall by the Princeton University Press under the title *Syria and the French Mandate: The Politics of Arab Nationalism, 1920-1945*. The second project involves new research on war and society in the 20th century Middle East. Quoting from the professor's report "This project is more broadly comparative and far-reaching than my previous ones. It focuses on what wars have done to restructure political and socio-economic life and to introduce new systems of ideas to the Middle East. Currently, I am examining Egypt during World War II and Lebanon during the civil war which began in 1975. The Class of 1922 award has provided me with the opportunities that would not have otherwise been possible. I feel privileged and honored to have been selected as a Class of 1922 Career Development Professor."

We are further advised by the provost that Professor Philip Khoury will be succeeded by Professor John Hildebrandt who is recognized as an accomplished poet, a writer of short fiction, and a scholar of English, Irish and American 19th and

20th century literature.

An article in the *Boston Sunday Globe* of January 26, 1986, by David Walsh on the high tech renaissance of Massachusetts refers to a "fascinating book" called *A Century of Electrical Engineering and Computer Science at M.I.T., 1882-1982* by classmate **Karl L. Wildes** and Nilo A. Lindgren, '48. This book, says Walsh, "at \$25—is about the best investment in understanding how Massachusetts works that you could make." See below about Wildes death in April.

Bill Freeman and his wife Charlotte traveled to and from England in September, 1985, on the *Queen Elizabeth II* for an interesting week in London including a visit to the American Bar Association memorial at Runnymede where the Barons "persuaded" King John to sign the Magna Carta. Bill's address is 106 N. Robert Rd., Bryn Mawr, PA 19010.

Harvey L. Williams died March 23, 1986, at age 85 at Delray Beach, Fla. He was an ambulance driver in World War I and later started his business career with Stone and Webster in Boston. He participated in the organization of several early air transportation companies including Aviation Co., the parent company of American Airlines. During World War II he was consultant to the development division of the U.S. Army ground forces headquarters in Washington, D.C. Later he became a vice president of H.J. Heinz Co. In 1953 he returned to AVCO and later he served as president of Philco International Corp. He is survived by his wife, three daughters, a son, ten grandchildren and five great grandchildren.

Lachlan Mackenzie, age 87, died November 30, 1985. His last address was in Santa Barbara, Calif., but he had been living in Sun City. In the early days when Lachlan was working in New York City and I in Newark we had many a round of golf together. In a foursome consisting of Bob Marlow, '17, Don Morse, '21, Lachlan and myself and playing at the Essex County Country Club in West Orange, N.J., Lachlan made a hole-in-one on the 180 yard 14th. That was in May, 1924. There were write-ups in the New York papers for this was the first time an eagle had been made on the 14th on a course then over 30 years old.

William J. Schaefer, Course X, died February 13, 1986, in Winter Park, Fla. He had been president of Schaefer Inc. in Stamford, Conn. . . .

Alexander L.M. Dingee, Course XIV, died April 28, 1986, in Watertown, Mass., at age 88. He is survived by his wife, Eleanor, a daughter, Barbara, and a son, Alexander, Jr. From the records I have, he also had a master's degree. He entered in his sophomore year and became an assistant in the Chemistry Department. . . . **Karl Leland Wildes**, professor of electrical engineering emeritus died April 30, 1986 at age 90. He studied electrical engineering at the University of New Hampshire, leaving in his senior year to take a half-time job as an instructor in the Department of Mathematics at M.I.T., a post he held from 1920-1923. He got his S.M. degree in 1922, was appointed assistant professor in 1928, associate professor in 1935 and professor in 1954. After his retirement in 1961, he pursued his interest in the history of electrical engineering at M.I.T. virtually non-stop. This resulted in his book with Nilo A. Lindgren referred to above. Professor Wildes was a widower. He is survived by a nephew, Karl A. Smith, of East Bridgewater. Our sympathy is extended to the families of these deceased classmates.

Remember our 65th Reunion coming next June in Cambridge. If possible, plan to attend.—**Yardley Chittick**, Secretary, Box 390, Ossipee, NH 03864

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Owing to the death of **Pete Pennypacker**, our second vice-president, **Royal Sterling** has moved **Lem Tremaine** from third to second vice-president and has appointed **Dave Joy** third vice-president.

Gerald Fitzgerald reports that he has been hospitalized for 12 weeks recovering from a hip implant and other complications. . . . **Frank Hart** died last January 13 at a Rockland, Maine, nursing home. After receiving his degree in architecture from M.I.T., he worked in structural design for Whidden Bickman Engineering Co. of Boston; American Bridge Co., Pencoyd, Pa.; W. H. Gilson Consulting Engineering; Bureau City Transit; U.G.I. Contracting Co.; Euyen S. Powers and Sons, Inc.; United Engineers & Contractors; Gravel and Duncan; and E. G. Budd Co., all in Philadelphia. In 1933 he joined E. I. duPont de Nemours and Co. for 14 years as assistant division purchasing agent involving non-ferrous, rare and precious metals and the procurement of special items for Oak Ridge and Hanford atomic energy plants. In 1950 he changed to the Delaware Research and Development Corp. In 1954 he was project engineer for building design and construction at Scott Paper Co., Winslow, Maine, until 1964 when he went into consulting. He was a member of the Camden United Methodist Church and the Camden Rotary.

Thomas Powers died on March 28. He studied courses in business administration with our class. He was a partner in Powers Brothers Hotels at Hotel Gardner, Fargo, N. Dak. . . . **Harry Thompson** died on February 12. After receiving his degree in civil engineering from M.I.T., he worked for 44 years as a civil and hydraulic engineer for the U.S. Bureau of Reclamation and retired in 1967. He was a member of the Masonic Lodge, Knights Templar, Al Bedoo Shrine, and the First United Methodist Church. His hobbies were flute playing, the Al Bedoo Band, photography, and fishing. —**Richard H. Frasier**, Secretary/Treasurer, 7 Summit Ave., Winchester, MA 01890

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The Boston Five—**Don Moore**, **Ray Lehrer**, **Don Fife**, **Russ Ambach** (**Dick Shea** was absent) had luncheon Thursday May 22nd and discussed the mini-reunion, the 65th Reunion, past winter activities and **Don Moore's** recent letter request for individual classmates career experiences. Latest report from the Institute was that 11 had been received. The highlight was the nine-page "sort of biography" from **Sam Helfman**, 1143 Chevelle Dr., Baton Rouge, La. **Sam** was executive vice president with Barnard & Burk, consulting engineers, and has been chiefly involved with the economics of municipalities in the South. . . . **Richard F. Shea** has been appointed by president **Don Moore**, and recommended by the Boston committee, to take over the duties of class executive vice-president vacated by the recent death of **Herb Stewart**. **Dick** was very active in the planning and operation of our 60th Reunion. During the summer, he resides at 7 Barkley St., South Yarmouth, MA 02664; and in winter, moves to 709 Cypress Lane, Sun City Center, FL 33570.

Don Moore was elated to attend commencement at Swarthmore College to observe his daughter, professor Sandra Faber, awarded an honorary doctor of science degree based on her valuable research on galaxies.

We have received word from his daughter, Nancy Hood, that **Willard C. Blaisdell** passed away June 12, 1985, probably in Elizabeth, N.J. He was awarded an S.B. and S.M. in electrical engineering co-operative. He began his career as a radio engineer with General Electric, moving to Stone & Webster. He then became vice president and chief engineer of a number of electronic companies, finally as president of States Electronic Corp., Linden, N.J., until he retired. He was a professional engineer, member of the Propeller Club and a Mason.

Ernest L. Kallander died April 18, 1986, in Southborough, Mass. He earned his S.B. and S.M. in chemical engineering and was an archery enthusiast and we believe owned a golf club in Southborough. Records indicate that he devoted his career to the Dennison Manufacturing Com-

pany in Framingham, Mass. as a research chemist. One of his five children was David, M.I.T., '51. —**Russ Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146

25

Karl R. Van Tassel of Lake Forest, Ill., whose long career as an electrical engineer and manager culminated in the presidency of A.B. Dick Co. of Chicago, has established the Karl Van Tassel Career Development Professorship at M.I.T.

President Paul E. Gray has announced that the first Karl Van Tassel Career Development Professor is Raphael C. Lee, M.D., a plastic and reconstruction surgeon who also holds the doctor of science degree in electrical engineering. Dr. Lee's appointment reflects the commitment of the Karl Van Tassel Career Development Professorship to support research that holds the potential for advancing the cutting edge of biomedical technology through the application of continuum electromechanics concepts to cell biology for clinical benefit.

Sam Spiker reports that while in Florida last winter he and Elinor had lunch with Marion and **Franklin Fricker**, and Eleanor and **Frederic Greer**. . . . Your secretary spent a week last June at the Cape Cod Hospital in Hyannis where he had surgery for the repair of two incisional hernias.

Belatedly we have received word of the passing of **Charles A. Dyson** on May 26, 1985 in New Rochelle, New York.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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Nathan Cohn, our active and forthright 60th reunion chairman, took a noteworthy cruise with his wife, Marge, in April. Sponsored by Stanford and the *Society Explorer*, formerly of the Lindblad fleet, the group gathered in Nandi, Fiji. They visited many islands in the South Pacific, including some wet landings from outboard-driven Zodiacs. They included Tikopia, the Reef Islands, Santa Ana in the Solomons, Alite, Honiara, Guadalcanal, Rendova Lagoon, and Kennedy Islands. After leaving the ship, they flew to Port Moresby, capital of Papua-New Guinea, then on to Sydney.

"There we enjoyed seeing the beauty and hustle of this burgeoning city and its friendly people," says Nathan. They proudly extended subtle reminders to American visitors that it is now the 'Australia's Cup.' The *Explorer* trip was excellent from every point of view. We had lectures on shipboard twice a day by competent members of the Stanford faculty on anthropology of the South Pacific, birds and fishes of the area, and astronomy (particularly the comet, which we could see on clear nights). There were few cuts of those classes. Altogether, a wonderful and educational vacation experience."

We highly recommend getting a copy of *A Century of Electrical Engineering and Computer Science at M.I.T. 1882-1982* from the M.I.T. Museum (\$25), particularly for Course VI men. Chapter 8, "Frozen Motion, **Harold Edgerton** and the Stroboscope," is an excellent portrayal of his development years with many good pictures. **Larry Grew**, a VI-A man, brought this volume to my attention. He is proud to be shown on page 127 with **J. K. Donald** (deceased) at G.E., Schenectady. They were assigned to a 13-week tour-of-duty with the talking movie labs, where they were involved with synchronizing film and phonograph records. Another photo is of **Russell Talbot** (deceased) on his knee timing the acceleration of a Boston elevated train.

W. Atherton "At" Witham died on August 13, 1985, in Cayucos, Calif. At was executive engineer, then vice-president of Miehle Printing Press and Manufacturing Co., which became a division of Rockwell International. He retired in 1963 and he and wife Fran moved to California, where he

became a citrus rancher and a consultant.

Barnett Silverston died on April 9, 1986, in West Palm Beach. Born in South Africa, he became a port and harbor engineering specialist. He was a retired partner of TAMS in New York. He joined the firm at its founding in 1942. Until his retirement in 1971, he directed the firm's work in the design of cargo and oil piers and wharves, pipelines, and dredging projects worldwide, including a major port in Amuay, Venezuela.

He was involved in marine terminal design in Brooklyn and Long Island City and the design of a Staten Island railroad terminal. He directed the design and construction inspection of the Bowater Paper Co., Pier 42, and the Belgian Line Terminals, Piers 35 and 36 on the East River.

Howard W. Page died on April 21, 1986, in Mamaroneck, N.Y. He had a most distinguished career. He was director, vice-president, and executive vice-president of Standard Oil Co. (N.J.), now Exxon Corp., the world's largest corporation.

In 1933 he worked as process engineer for Esso Research and for several years thereafter was stationed in Paris and London as assistant manager of SONJ European refining office. From 1942-45 his company made him available as a "dollar-a-year" man with the Petroleum Administration for War in Washington dealing with production and distribution problems.

Returning to Esso in 1945, he took on increasing management responsibilities in this country, London, and the Middle East, and was chairman of the negotiating team which in 1954 resolved the issues resulting from Iran's nationalization of its oil industry. Throughout this period, he figured prominently on negotiating teams dealing with Middle East governments for the Iranian Consortium, Iraq Petroleum, and Quatar Petroleum Companies. From 1954-66 he served as a director of Arabian-American Oil Co. and was a key figure in establishing Aramco's policy in its dealings with Saudi Arabia.

Howard retired in 1970, but kept an active membership on the board of trustees of the American University of Beirut from 1955 to 1976. He was elected vice-chairman in 1959 and chairman in 1973. He was a founding member of the AUB Foundation, serving as chairman for ten years. He was also a director of the Near East Foundation and a member of Council on Foreign Relations for 25 years.

We extend our sympathy to the families of these men.

Harold "Bud" Fisher was a close associate and friend of Howard's because he followed his various positions in London and the Middle East, became a director and vice-president of Exxon.—**Joseph C. Burley**, Secretary, RFD 3, Epping, NH 03042; **Lawrence B. Grew**, Assistant Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole**, Assistant Secretary, 2150 Webster St., Palo Alto, CA 94301

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Jim Donovan received a note from **Kanshi Minocha** (in Bhopal, India) relayed through Kanshi's son, who is presently in the U.S.A. Kanshi sends his warm greetings, thoughts, and sentiments together with a reiteration of his philosophy of life as expressed in the poem *Salute to the Dawn* by Kalidasa. . . . It is always a special pleasure to hear from Mary and **Max Parshall**. At the time of a recent letter, they were both recovering from the flu which hit them in spite of protective shots that normally have been more effective. They are planning another cruise to Alaska this fall on the same ship as last year. They hope also to make another trip to Colorado this year.

Last May 12 your class officers (**Donovans** and **Smiths**) participated in the LYBUNT telethon at the alumni center in Cambridge. A LYBUNT, you must know, is an alumnus (usually well intentioned) who supported the Alumni Fund "last year but not this." We were a bit surprised, per-

haps but very pleased to find there were no '28 LYBUNTS to call. Our congratulations to all of you! Don't think that our visit to the Institute was wasted, however. We were cheerfully given call cards for other classes and so added something to the evening's progress.

Technology Day, June 6, was a pleasant occasion with the following classmates attending some or all of the events: **Frannie and Jim Donovan**, Janet and Fred Lewis, Al Puschin, Florence and **Walter Smith**, Ann and Will Tibbetts, Ruth and **Abe Woolf**. **Lazare Gelin** wrote to say that he had originally intended to be in Cambridge for Technology Day but became scheduled for hospitalization on that day. Lazare reports that he has been in contact with **Morey Klegerman** who lives in Bronxville, N.Y., and still goes to his office in New York twice a week.

You may recall that in our last notes we expressed a wish for some more extensive biographies on our classmates. Almost as though by ESP, in just a day or two after mailing those notes, a letter came from **Helen (Mrs. Robert S. Harris)** enclosing a beautifully written account of Bob's life (by an associate) covering nearly all aspects, personal and professional. Of course, we will share it with you later. We seem to have made a good start on the general idea. If you have been thinking of writing something of your life story for posterity, perhaps this is a good time to start. Don't forget to send us a copy.

With deep regret we must report that **Irl R. Clarke** died on January 15, 1986. Verification was received from his daughter, Betty James. Irl studied in Course VI, electrical engineering, then completed his education at Rhode Island College of Education for a career in teaching. In 1953 Irl announced that he planned to retire early and move south to Georgia. This he did and later wrote to say he was thoroughly enjoying his retirement there. To Irl's family we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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Helen May Walther of Blairstown, N.J., writes: "My 80th birthday was the big event of last week. All my children and their spouses (or the equivalent) came for the weekend (plus), from England, California, Guatemala, and Massachusetts for a glorious house party (I still live in my big farmhouse). Next month, we will have a Walther family reunion. Life is never dull here." Among her hobbies Helen lists "nature, entertaining, reading, *London Times*, and crosswords puzzles." . . . **Edwin H. Perkins** of Georgetown, Mass., writes, "With passage of time, I am gradually becoming less involved in activities. I am still treasurer of Eastern Star, educational officer of District 18 (Essex County), U.S. Power Squadron." Edwin and his wife Ruth have one child and two grandchildren, and he lists sailing as his main hobby. . . . **Romeo H. Guest** of West End, N.C., is semi-retired but is still in charge of his business enterprises. He says, "My claim to fame will be the establishment of Research Triangle of North Carolina."

A note from **Gordon R. Williams** of Weston, Mass. states that his wife Olive has been confined since last August, first for two major operations, then a fall and a broken ankle last October. On a happier note, they celebrated their 55th wedding anniversary on March 21 and Gordon joined the "club" on March 26 by becoming an octogenarian. Brigadier General **J.E. Howarth, Jr.** of Arlington, Va., has retired after 16 years of service on the board of trustees, Second Marine Division Association Memorial Scholarship Fund (seven years as chairman). . . . **Takao Kuki** of Tokyo, Japan, writes that he and his family are well, except that his wife has recently developed glaucoma. Fortunately, it is currently in a stable condition. He says, "Last month we enjoyed a visit from President and Mrs. Paul Gray, '54, and Professor and Mrs. Samuel Goldblith, '40, of M.I.T. as guests of

the M.I.T. Association of Japan. We attended a dinner party at which time President Gray showed us some slides of the present-day M.I.T. campus compared with that of our time half a century ago. He also told us about M.I.T.'s future plans, goals, and aspirations." I received a note from **Chung Foy Yee** of Guangzhou, China, is still teaching at the South China Institute of Technology. He writes, "for my recent birthday (80th) and for 30 years of teaching at the institute, a party was held in my honor with nearly 100 people attending. I was supposed to go to M.I.T. for the 125th anniversary of its founding, but I was not feeling too well and my doctor advised against such a strenuous trip. I am alright now and hope to attend our 60th reunion in 1989. I hope I will make it. Greetings to all my classmates."

Florence, wife of **Ted Malmstrom** of Honolulu, Hawaii, writes, "We now have a great-grandchild, Kristin, born April 26, 1985. It is quite exciting having a little one around the house again. She is beautiful but gets in everything. Ted is still enjoying Hawaii. Our daughter Polly, who lives in Reston, Va., surprised him with a visit to celebrate his 79th birthday. We had a great time. Ted still manages to get around with a walker, and when we go out, he uses a wheelchair. We wish class of 1929 would consider coming here for the 60th reunion. It is a beautiful place, and I am sure you all would enjoy it. Aloha!"

There are a few '29ers who are smart enough to induce their wives to act as their corresponding secretaries. Case in point, **Frank Mead** and his wife Mary. The latest addition to the list is Fran, wife of **Paul Donahue** of Nahant, Mass., who writes, "Recently we took a trip to Hawaii, and we had a great visit with **Florence** and **Ted Malmstrom** in their home in Honolulu. They wined and dined us, and we talked about old times, the present, and the future. It was the highpoint of our trip. Paul is a director of the National Association of General Contractors of America. He is on various committees, which meet in different parts of the country, so we do some interesting traveling. We have two married daughters, one in Virginia who we visit. We are blessed to have our oldest daughter living near us. Their four lively children, ages 14 to 21, keep us up on our toes. We are humbly thankful for our blessings, most of all for your interest and friendship. We send our love to all our classmates, and may we all meet again at our 60th reunion."

I regret to announce the deaths of the following members: **William L. Hilliard** of La Jolla, Calif., on April 7, 1985; **Arnold S. Wood** of Osprey, Fla., on April 14, 1985; **Carl F. Norbeck** of New Haven, Conn., on September 21, 1985; and **Ray C. Williams** of Calumet City, Ill., on December 24, 1985.—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

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This month's most extensive communication is from **Ralph Draut**, who reports that he retired from the aircraft industry in 1974. Most of his working career was spent with Martin-Marietta on engineering assignments in Baltimore, Omaha, and Orlando. For the last six years before his retirement he worked for the Federal Aviation Administration on the supersonic transport (SST) program. He says that, although the program was discontinued by act of congress, he is confident that an economical and reliable SST will be built in this country before too long. He still does a bit of work for American Institute of Aeronautics and Astronautics in Washington from time to time. Ralph's first wife died in 1970, and he has remarried. He and Maxine have five children and five grandchildren and help keep AT&T in business by making many long-distance calls to keep in touch with their widely scattered family. . . . **B. Alfred Carideo** retired about ten years ago as development engineer at the Army Research and

Development Laboratory in Natick, Mass. He is now "living a life of leisure including some traveling and some chores around the house and yard." . . . **Charley Dwight** has established a permanent home on the island of St. John in the U.S. Virgin Islands. He spends nine months of the year there and the other three months (mid-July to mid-October) with a sister in Castine, Maine. He is active in the Lions Club, Yacht Club, and Historical Society of St. Johns, as well as in the Virgin Islands Conservation Society and the Great Cruz Bay Association.

Doris and Les Engler are still shuttling between Ft. Lauderdale, Fla., and Quechee, Vt., twice a year. Les is on the board of their apartment complex in Florida and does volunteer work at the Mary Hitchcock Hospital in Hanover, N.H. during the summer. . . . Last April **Earl Ferguson** completed five years of tax counseling for the elderly. He finds that this volunteer effort is greatly appreciated.

We have at hand a number of letters and articles that **Win Hartford** has had published on such subjects as professionalism, higher education and the environment that **Greg Smith** has kindly forwarded to me. There is no way that I can adequately summarize them in the space available, but there is one point he makes that is of special contemporary interest. In an article entitled "Roadblocks to Professionalism," Win writes: "The scientist-employee is not truly a professional until he has established a relationship where the employer . . . recognizes the scientist's right to convey objective professional opinion without distortion. There are two impediments to this sort of relationship. . . . The first of these is bureaucracy. . . . As the bureaucracy becomes established, communication from the top overshadows significant communication to the top; seniority and tenure override professionalism, and financial reward may depend on telling top management what it wants to hear." Having written the foregoing in 1984, Win must have been quite fascinated by the TV and press coverage on the reasons for the *Challenger* disaster.

Joe Harrington died suddenly on June 13, 1986. As many of you know, after graduating from M.I.T. with our class and obtaining a doctorate in mechanical engineering in 1932, Joe went to work for the United Shoe Machinery Corp., where in due course he became assistant director of research. In 1955 he moved to Arthur D. Little, Inc., where he headed the mechanical engineering group until his nominal retirement in 1970. The word "nominal" is aptly applicable in this case because he continued to maintain an office at ADL and was a very active consultant until the time of his death. Joe's principal field of interest, and one in which he acquired a considerable reputation, was the automatic control of manufacturing processes. He was a founder of the Numerical Control Society (now the Association for Integrated Manufacturing Technology) and its president in 1970-71, as well as a prolific writer on this subject. Perhaps his best known publications were *Computer Integrated Manufacturing*, published in 1979, and *Understanding the Manufacturing Process* published in 1984. He received the *American Machinist Magazine Award* for "perceiving computer integration as the key to the factory of the future, helping foster its implementation, and contributing to the understanding of the essential nature of manufacturing." Also he was the subject of a highly laudatory cover story in the December 1984 issue of *American Machinist*.

In the area of public affairs Joe served as town moderator of his home town of Wenham for more than 25 years, as well as being a member of the board of selectmen, the library board, the board of health and the finance and advisory board.

Notwithstanding the manifold activities outlined above, he found time to devote to a number of M.I.T. affairs, notable as our former class president, member of the Alumni Council, vice-chairman of an area committee of the 2nd Century Fund, and a contributor to the plans and arrangements for a number of reunions. The Harrington

family has multiple connections with M.I.T.; our classmate is the second of four generations of Joseph Harringtons to attend the Institute. The others were or are in the classes of 1896, 1961, and 1988. Joe is survived by his wife Alene, whom many of you have doubtless met at class reunions over the years, as well as by two daughters: Joan Smith of Hillsboro, Ore., and Anne Heider of Evanston, Ill.; Joseph Harrington III, Joseph Harrington IV, and four other grandchildren.—
Gordon K. Lister, Secretary, 950 N. Abrego Dr., Green Valley, AZ 85614

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Ben Steverman, our 55th reunion chairman, sent the following report. "The 55th reunion is now history, but it is good to review some of the high points for those of you who couldn't make it. In spite of the terribly rainy weather, we had a great time. Most of us made it for the complete four days. About 90 classmates, spouses, and guests attended. On Thursday, after registration at Burton, we had dinner at the Stratton Student Center and then were bused to Pops. John Williams entertained us with several of his own compositions, a few oldies, and, of course, our alma mater. We then 'swam' to the buses for our return trip.

"On Friday morning we had an interesting seminar at Kresge, followed by the Alumni Luncheon at the Athletic Center. We then left Cambridge for the Wychmere Harbor Club in Harwichport. At Wychmere on Friday night, we enjoyed a social hour and then a real New England clambake. A wandering minstrel supplied the music, and most of the entertainment was supplied by the diners. Saturday was spent enjoying surroundings. Even in the rain the Cape is a nice place to be.

"After a day of prowling around the beaches and towns and looking over memorabilia from our graduation and other reunions, we again got together for our class dinner. Election of officers was promptly taken care of by re-electing the present group. **Wyman Boynton** generously donated a historic picture of the Rogers Building to the class for presentation to the M.I.T. Museum. The picture, taken in about 1870, had been in the family of a M.I.T. alumnus of the class of 1872. Wyman made the formal presentation to **Ken Germeshausen** as representative of the M.I.T. Corporation. President **Dave Buchanan** looked to the future and the 60th reunion.

"A trip on the Mississippi River for the spring of 1988 was favored for the interim reunion by those present, and Polly Germeshausen graciously accepted the responsibility for moving forward with those plans. **Dick Ashenden** and **John Swanton** accepted the appointment to co-chair the 60th reunion. Charlotte Hubbard introduced our speaker of the evening, Clair Baisly. She gave a most interesting talk on the history of Cape Cod. After lunch on Sunday, we went our separate ways happy that we had renewed old friendships and captured some memorable moments that will live on to enrich us forever."

Sadly we report the deaths of the following: **Mrs. Harold H. Carr** in 1986, **Arthur E. Jorjorian** on April 4, 1986, **Harry Landsman** on January 24, 1986, and **John N. Fricker** on March 8, 1986. Our sincere sympathy to their families.

En route, on our return home, Helen and I had a serious accident and ended up in a hospital for about a week. Thank goodness we are both alive and rapidly recovering.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben Steverman**, Assistant Secretary, 2 Pawtucket Rd., Plymouth, MA 02360

we are getting fewer and the classes after us are increasing. Those of us attending were as follows: **Wendell Bierce**, **Donald Brookfield**, **John Brown**, **Melvin Castleman**, **Albert Dietz**, **Richard Lobban**, **Charles Taylor**, **Thomas Weston**, and **George Kerisher, Jr.**, who came as a guest in memory of his father, our departed treasurer.

There was a very impressive memorial service for M.I.T. alumni who died in the year preceding April 30, 1986. Those listed in the class of 1932 are as follows: **Ira J. Bach**, **Edwin C. Beck**, **Harry F. Carlson**, **A. Cameron Crosman**, **Donatiel L. Dionne**, **Lawrence W. Grady**, **Kirk Horigian**, **George K. Kerisher**, **Neil M. MacLaren**, **James M. McMartin**, **John E. Meade**, **John A. Osterman**, **Samuel E. Paul**, **Edwin B. Powell**, **Gardner H. Prescott**, **N.E. Rothenthaler**, **Benjamin Shreve**, **Maurice D. Triouleyre**, **Rolf V. Wallin**, and **Joseph Welch, Jr.**

Don Brookfield, our class president, held a class meeting. All those listed above as attending the present reunion agreed to serve on the 55th reunion committee. In addition, the following classmates have indicated their willingness to serve: **Robert Minot**, **Arthur Marshall**, **John Finnerty**, **John "Nick" Flatley**, **Joe French**, and **Al O'Neil**. Don is hoping other classmates will step forward. The more on the committee, the better! **John Brown**, our treasurer, reported our bank balance at about \$4,400.



Arthur Metcalf

Arthur G.B. Metcalf is an alumnus of M.I.T. '32, Boston University, and Harvard. He has taught at all three institutions. In January, the trustees of Boston University unanimously voted to name the University's new \$100 million Center for Science and Engineering for the chairman of the university's board of trustees, Arthur G.B. Metcalf.

The Metcalf Center is a four-block-long complex of new and renovated buildings which contain laboratories, classrooms, lecture halls, advanced computer and other research equipment, a library, and greatly enlarged science and engineering facilities. The Metcalf Center is the realization of a carefully planned and sustained effort by the university to improve its educational and research programs in science and engineering.

Donald Gilman has returned from several weeks in Tunisia. He says his health is not as good as he would like. He is looking forward to coming to our 55th reunion. He sends greetings to all his friends and classmates.—**Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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Anne and **Fred Murphey** sent a pretty postcard from Bermuda when they were there last summer. They had been to an M.I.T. dinner in Boston and saw Marion and **Dick Morse**, our president, and Elly and **Mal Mayer**.

The class has a memorial gift from **Mrs. George Isserlis**. It has been forwarded to **Herb Grier**, our class agent.

No word from **Clarence Westaway** since Christmas. Has anyone news of him? . . . **Jack Andrews** says my fingers must fly ever faster to answer the letters that come. To tell the truth, the fingers are not flying . . . they do just keep at it.

Try me; see if you get a reply to any note you sent this way. Jack comes through with news of his family; he and Jermaine have traveled back and forth from Montreal to Florida this year visiting family. He reports that **Charlie Britton** in West Hartford was readying his garden. They expected to get to Nags Head on the North Carolina coast during the summer and maybe to the Canadian Rockies.

Huston Associates of Crofton, Md. is busy as can be. **Bill (Huston)** is involved in climate forecasting and hints that he may discontinue work by year's end. Dot will retire too. Bill saw Mabel and **Quimby Duntley** in California. A full letter from **Harry Summer** reminds the Whittons that we sat with him and Cele at Pops for the 50th. . . . My how time flies! He reports seeing M.I.T. decals on cars in Evanston. I have given up being an educational counselor. Miss it, but not enough to want to get back in harness again.

Do you remember the *Senior Superheater* issued at our graduation? **Ed Wemple** sent me a copy. Mentioned were **Charlie Bell**, **Lem Smith**, **Robert Holt**, **Lou Flanders**, and **Gus Kidde**. . . . **Neil Hopkins** of York, Pa., sent the program for a musical presentation he takes part in now and then. He is erecting a 10-by-15 building at the back of his lot . . . just taking the bread from the mouths of us professionals. He sent along a picture of Halley's Comet made with his self-made telescope.

Steve Rhodes sent news from Taunton, but the letter is misplaced. Would you like to write him? Ask me for his address. . . . **Robert Dobson**, living in Lincoln, Neb., hears from **Cooper Cotton** and **Cy Hapgood** now and then.

Word comes that **Lennox Lindsay** passed on in the early spring. He was living in Laramie, Wyo. . . . **David Babcock**, who was living in Rochester, N.Y., died in January. Let me know you can still spell . . . send news.

I never run across class members down here, but **John Longley** gave me the name and phone number of an M.I.T. man (1935) who lives in Charlotte. We have called back and forth, and by the next issue we will know what he has to contribute to these efforts.—**Beaumont Whitton**, Secretary, Cottage 112, Sharon Towers, 5150 Sharon Rd., Charlotte, NC 28210

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There are four more losses to report. **Carroll Fennessy** died in Eugene, Ore., on November 13, 1985. He spent most of his career with Phillips Petroleum and the government on industry relations and policy. He is survived by his widow Harriet, a son, a daughter, and grandchildren and great grandchildren. He and his wife had moved to Oregon to be near his daughter and her family.

On March 3, 1986, **Julius Goldberg** died in New Bedford as a result of a massive stroke. He had been a retail hatter and had his private pilot's license. He leaves his wife Clara, two sons, and a daughter. . . . **Leslie Doten, Jr.** who was living in Silver Lake, N.H., when he died on March 16, 1986. He spent most of his career at Nabisco Confections in Cambridge, where he became executive vice-president. He is survived by his widow Myrtle, a son, a daughter, and four grandchildren.

Walt Wrigley sent me a clipping about the death of **Kenneth Ryder**. There was no date on it but I presume he died early in July. He died in Longmeadow, Mass., where he had lived for the last 40 years. Ken had worked earlier in his career in the packaging machinery field but then had moved to Hamilton Standard in East Hartford. He retired from there after working with them for 24 years.

Ken had been active in civic affairs in the Springfield area; he was a director of the Food Bank for Western Massachusetts, the Open Pantry in Springfield, and was a former director of the Springfield Council of Churches. He leaves his wife Margaret, with whom he had celebrated

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Several of us attended the M.I.T. reunion in June. We could not help noticing that the classes before

their 50th wedding anniversary on June 14, a son, four daughters, a brother, and eight grandchildren. To all the wives and families of those we have lost, I offer sympathy in behalf of our class.

In a pleasanter vein, I received a copy of the *Friends of M.I.T. Sailing* newsletter. It mentions the Sailing Association's Hinkley 38 *Aleida*, which was a gift from **Albert Hopemen** in our class. This is certainly a most unusual gift in support of an Institute activity, and its maintenance (as a former owner of a cruising sloop, I know this is no small matter) has been made possible by an endowment gift by a member of the class of '48.

I warned you earlier that if you didn't give me something for these notes, you'd be condemned to reading about some of my travels. I had signed up for the Quarter Century Club trip to Vienna, Salzburg, and Munich, with an add-on four-day boat trip down the Rhine from Basel to Rotterdam. Five people with M.I.T. connections had planned to be with the group. However, Mary and Bob Hawthorn, Sc.D.'54, from Houston and I were the only ones who showed up for the tour, from an original 36. The rest had apparently chickened out over the much-publicized terrorist scare that had almost emptied Europe of Americans this spring. There were, of course, no problems, and I don't think the American image has been enhanced by our general turning tail and running. We were amazed that the tour wasn't been cancelled, but the end result was great for us—just we three, our driver with a Mercedes, and local guides in the three big cities.

The boat trip down the Rhine was fun; we were able to get short tours in Strasburg, Heidelberg, the Reisling wine country, and a little around Cologne. We were fortunate to have beautiful weather the day we were going past all the castles—from Mainz to Cologne. But that trip was a disaster for my waist line—two five course meals a day! I know—there's no law that says you have to eat them—but it takes more will power than I had to say "no." They were delicious.

One thing of interest to engineers: on the lower part of the river, the Dutch have built very striking suspension bridges for the road crossings. There are two, or sometimes only one, tower with single tension bars, almost like strings on a harp, supporting the roadway structure.—**Robert M. Franklin**, Secretary, P.O. Box 1147 (620 Sackett Rd.), Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20815

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Just received the following letter from **Sam Brown** which would, at this date, find him back in their Pocono Springs home after the trip to Norway described in the letter. "We are leaving Florida in a couple of days, and from June 7th until September 2nd we shall be at our Pocono Springs home; back here at Punta Gorda by September 7th. Obviously, we are not going to get over to Cambridge for Alumni Day for the first time in about five years. "Natalie and I are booked to fly to Norway June 22nd to be there for the longest day, which they call 'Midsummers night', then to take a 12-day mailboat trip up the coast to Kirkenes and back to Bergen. We plan to spend a few days each in Oslo, Stockholm and Copenhagen, with an SAS flight back to U.S. in mid-July." Sam also asked if I knew how **Bob Lindenmeyer** was. I did not so I called him up and learned he is feeling much better, and playing some golf and confirmed the fact that he's in the swing with his poker group which, incidentally, includes **Bernie Nelson**.

Professor Ernest G. Cravalho is the first holder of the new Edward Hood Taplin Professorship which links M.I.T., Harvard and the Mass. General Hospital in a pioneering medical engineering program. The Professorship was established by **John T. Taplin** and his family. John is senior consultant for Harvard Medical School. He recently

established the National Health Research Foundation of which he serves as president. We are very proud of you, John, and wish you well in your endeavors.

Friends of M.I.T. Sailing sent me a copy of their newsletter to give me the news that **Larz J. Anderson** donated his Etchells 22 to the Pavilion. Larz won the last series in the "ultra hot" E22 fleet in Marblehead in summer '85. It seems that M.I.T. and Salem State which also has some donated E22's hope to sponsor the larger boat racing in colleges. This is a 30 footer. Speaking of 22's reminds me that I gave **Arthur Haskins** rather short shrift when describing his exploits with his Tanzer 22 in the '85 season. In open class handicap racing, he took 1st in both the July and August series in Harpswell Sound and 2nd in the Casco Bay Interclub Regatta in Portland. In one-design racing in South Freeport, Maine, he retained his Tanzer 22 Maine State Championship title and took the U.S. Championship at the same time. All of this was close racing with the final point scores only fractions of a point apart. This year, Art has three perpetual trophies to defend, or there will be hell to pay at home. Dot says she doesn't want holes in the living room wall where the trophies hung! One of you had better let me know just what happened this season!

I regret to report the death of **Benjamin M. Gruzen** who died in Campbell, Calif. in March, 1986. . . . **George C. Morrisette** sent a note through the Alumni Office: "Have been retired for more than seven years and married for nearly 50 years. Have two sons and two grandchildren—a boy and a girl. Was unable to make the 50th reunion but would like to get a copy of the reunion booklets. My plans are to stay in the Louisville, Kentucky area."

I'll save the details of my Alaska trip until next notes when I may be needing something to write about.—**Allan Q. Mowatt**, Secretary, P.O. Box 524, Waltham, MA 02254

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Almost all rain, but the spirit and fellowship of the 50th prevailed. Over 100 classmates participated, and many, many more contributed to the class gift. We will leave the honor of reporting it to the Gift committee, who deserve an accolade along with all the givers.

By now you should have received the bound biographies of all who submitted them—some 226. The volume is only one of the many results of the reunion committee's diligence in staging a fine reunion. **Alice Kimball** and her group deserve our utmost thanks for their hard work. These class notes in the future will assume your knowledge of the biographies, and build on them. If your copy has not arrived, please notify Alice promptly, giving your current address.

The 50th year class meeting produced several good and witty speakers: **Bob Gillette** on the birth of the Nautical Association in 1935-36. . . . **Stan Johnson** on track history and his father, trainer "Pop" at the field house. . . . **Hank Lippitt** and **Lou Stahl** on the Class Gift. . . . **Laddie Reday** on his unique travels. . . . **Harry Essley** quoting the 1936 thesis of **John Easton** and **Bob Worden** (both deceased) on the then-new Social Security, a remarkable foretelling of the problems we know today. . . . **Dorian Shainin** wound up with his usual bon-mots.

The meeting also revealed a major surprise—**Tony Hittl** preferred not to continue as president, after so many years of carrying that responsibility. All of us, present and not present, owe him a debt of gratitude.

Jim (Pat) Patterson for the nominating committee presented an obvious shoo-in replacement—**Alice Hunter Kimball**, and a resounding unanimous vote showed our appreciation for her 25 years of devotion to the Class as secretary. She was given a large bronze medallion M.I.T. seal, which will grace the home where so many have been entertained at mini-reunions.

The rest of the slate were **Ed Dashefsky**, vice-president; **Eli Grossman**, treasurer and myself, secretary. After the election Alice appointed **Pat Patterson** assistant secretary, and with him in the East and me in the West we hope to measure up to Alice's wide single-handed coverage of the Class. Please—all of you—send us a 14-cent postcard of items interesting to your classmates.

At the Chatham Bars Inn the rain continued Saturday and Sunday almost until parting, but some golf and tennis took place. Fortunately, three of the accommodations had sizeable living rooms where members gathered amid photos and other memorabilia, with refreshing liquids to warm the hearts and atmosphere. The food was excellent.

Now a few notes on some who could not make it. **Rob Wead** in Hawaii had to cancel at the last minute due to a business problem. **Ken Winsor** in Italy had a deadline to meet on a sculpture for Lufthansa Airlines. Both had written at the 45th of their intention to row in the Class eight at the 50th, joining **Slim Beckwith**, **Herb Borden**, **Henry Johnson**, **Tom Johnson**, **Bob Lutz**, **Fred Noyes**, **Milner Wallace** and myself. I talked with Rob and Ken by telephone—they are in good health and wish to be remembered to their friends. Also by telephone **Mike Kuryla** was found at 2769 S.W. 22nd Ave., Miami, FL 33133. This is not in the Class Directory, Mike having left Lima, Peru, and new address unknown at publication.

We hope that individual pictures taken at the reunion will be copied and circulated to others. Pictures of the crew in action, taken by wives in the launch are available, and perhaps we can act as a clearing house for other photos.

Word has just been received that **Jack Austin**, our president at graduation and for years after, died of a heart attack August 8, 1983 in a suburb of San Diego. If more information comes to light it will be reported in future Notes.—**Frank Phillips**, Secretary, 901 Los Lovatos, Santa Fe, NM 87501, (505) 988-2745; **James Patterson**, Assistant Secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

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Dr. Bertrand E. Bennison, Box 224, Eastham, MA 02642 writes, "I seem to have slid effortlessly into a generally satisfying mix of miscellaneous local activities and interests, which we happily share with congenial others. Between League of Women Voters and American Association of University Women, my wife also gets involved in a comfortable variety of activities, not excluding a peace ribbon safari to Washington, D.C. Our offspring are finally emerging from the boomerang stage, but still enjoy visiting Cape Cod. The distant thunder of conflict resolution by less than rational means intrudes now and then on our septuagenarian serenity. Closer to home, the pervasive environmental degradation occasionally tones up what remains of my 'fight or flight' system. As a super-annuated 'medicine watcher' I feel for colleagues presently in mid-career. Our transition to a universally available, collectively financed health care system is not easy. I can't believe our 50th is coming up."

Lawrence G. Cyr, 83 Brookfield St., Lawrence, MA 01843, writes briefly that he retired in 1975 as a draftsman with Archibald McLaren and last travels in '56 were to Spain, France, Germany and England. . . . **John H. Fellouris**, 1290 Rockdale Ave., New Bedford, MA 02740 writes, "In August 1983 I sold my building construction company, but kept my development company. This now makes it possible for Peggy and me to take off for a couple of months at a time; so we got into boating with a vengeance. It was quite an adventure for us to navigate on our own motor yacht from New Bedford, Mass. to Ft. Lauderdale, Fla. down the Intercoastal Waterway. It is fortunate that Peggy is such a great sailor. We have been spending our winters cruising around Florida and when

we are not cruising, we live on our boat at a marina at Pompano Beach, Fla. This has also given us the opportunity to have dinner with two classmates: **Joe Smedile** and his wife Martha, who live in Delray; and **Lincoln Herzeca** and his wife Jolette, who live in Miami. It was also a great experience for Peggy and me to spend nine weeks last summer touring by automobile from Maine to Yellowstone Park, the Grand Canyon, Zion National Park, the south West, etc. It takes a leisurely trip like this to realize what a great, beautiful country we have! Parts of the winters and most of the summers we spend in New Bedford enjoying visits by one or the other of our six daughters, sons-in-law and grandchildren. During these times in New Bedford my development work keeps me fairly busy. This year especially, I am quite excited about putting up a development right on New Bedford's historic waterfront.

Meanwhile, Peggy, who has a Ph.D. in nutrition, completed her book. Because of her many years as executive director of the American Red Cross of Greater New Bedford, she finds herself still involved in various civic projects. As you can see and as it so often happens, we are more busy now than ever!"

Robert C. Glancy, Jr., 41 Grandview Ave., White Plains, NY 10605, retired July 1, 1980, as New England Region Planning Engineer, AT&T Long Lines. Non work activities are: tax counseling for elderly, vice-president Friends of Library, and various offices in church. Hobbies are: growing under lights, astronomy, stamp collecting, computers and a cottage in N.H. on Lake Waukewan. Travels have been to Hawaii, Panama Canal, Caribbean, Great Britain, Scotland, Netherlands, Belgium, France, Denmark, Scandanavia and Leningrad. Wife Carrie's main interests are sewing and gardening. Robert writes, "have been enjoying retirement. The days aren't long enough. Currently very active in repairs to church. Spending a lot of time mastering AT&T PC 6300 computer. Doing some simple programming. Spend most of every summer in Meredith, N.H. Been there nearly every summer since 1943. Have enjoyed class reunions—hope to make our 50th."

Sidney Levine, 8350 Moon Rd., Saline, MI 48176, writes that his wife is deceased and he has four children and four grandchildren. He was editor from 1960-1984 of *Minerals Processing*, *Rock Products*, *Pit & Quarry*, *Modern Concrete*, and *Ceramic Age* magazines. Former positions included lacquer chemist, piping and chemical plant layout designer, chemical equipment operator and chemical engineer on the Manhattan Project at Columbia University. He published about 400 articles in editorial positions and freelance technical writing. He retired in 1984 and is now living with daughter Kate's family on a ten-acre spread. His activities include grass-cutting and snow-blowing via a 10-hp tractor, feeding firewood to an alternative-energy heating unit, and entertaining granddaughter Katrina. His current plans include visiting all the grandchildren, writing a book on construction minerals end-uses, and starting an herb garden.

Austin C. Loomis, Tunxis Club, Tolland, Box 150, Granville, MA 01034, writes briefly that he and wife Elizabeth traveled to Australia and New Zealand last winter. He retired as a test engineer with P and WA of UAC. . . . I regret to report the death on January 8, 1984, of **Albert C. Faatz, Jr.**, 3 Briar Hill Rd., Montclair, NJ 07042. He is survived by Mrs. Albert C. Faatz (Abby) and 2 daughters Katrin and Pamela.

Our secretary just received a letter from the Alumni Association offering to help us prepare for our 50th. Do not forget June 1987 at Wequasset Inn, Pleasant Bay, Chatham, Mass., on Cape Cod. If you have not returned your questionnaire for our 50th year reunion class book, please do. If you lost it drop me a card and I will send you another form.—**Lester M. Klashman**, Assistant Secretary, 289 Elm St., Apt. 71, Medford, MA 02155; **Robert Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155

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Last June 25 a reception was held in the M.I.T. Bush Room to honor **Don Severance** upon his retirement. Don spent his entire working career (48 years) at M.I.T., starting in the Registrar's Office and as a teacher. From there he moved to the Alumni Office where he became executive vice-president. At the start of the Leadership Campaign, he was asked to take charge of the personal solicitations as director of Leadership Gifts. He stepped down from that post in 1984 but continued to work as a consultant to Resource Development.

Over 100 people attended the reception, including alumni, family, and colleagues past and present. Attendees from the past included Ken Brock, '48, Fred Lehmann, '51, Jacquelyn Findlay, '44, and Doris Evans. In recognition of Don's service to M.I.T., he was presented with a large Steuben Beaver.

Remarks were made by Glenn Strehle, '58, treasurer and vice-president for Resource Development; Jay Stratton, '23, president emeritus; and Jim Killian, '26, president emeritus and past chairman of the Corporation. Both Jay Stratton and Jim Killian included Phyl Severance in their tributes to Don, noting that she was also retiring after 48 years service to M.I.T.

A graduate fellowship in the name of **Ascher Shapiro** was announced on the occasion of a retirement dinner in his honor at the Faculty Club.

A note from **Bill Brown**, now residing in Kensington, Calif., states that he enjoys retirement travelling, and when home prints color pictures of the trips and, last winter, Halley's Comet, which he photographed from Marin County, Hawaii, Mexico and elsewhere. . . . **Bob Wharton** summers at Black Point Beach Club in Niantic, Conn., where he fishes and lobsters. He reports that he found an excellent specimen of an archaic Indian spear point while digging out the stump of a spruce tree blown over by the 1985 hurricane.

Your secretary left sunny Cape Cod recently to spend a week climbing various trails on Mount Katahdin with son Bob Bruneau (M.I.T. 1969). I had forgotten what it is like to carry a pack, and believe it or not, I think the mountain has gotten higher since the last time I was there.

The mini-reunion at Endicott House on June 6 was a great success. Attendees included Hilda and **Norm Bedford**, Ruth and **Paul Black**, your secretary and wife Sandy, Winnie and **Bob Campbell**, Madelyn and **Paul Des Jardins**, Ina and **Haskell Gordon**, Jean and **Ed Hadley**, Horace Homer (Roberta was ill), Pat and Bob Johnson, Sylvia and **Sol Kaufman**, Ruth and Frank Kemp, Muriel and **Norm Leventhal**, David Morse, Marie and **Paul O'Connell**, J.J. Phillips, Harry Saunders, Hope and **Phil Sellers**, Phyl and **Don Severance**, Millie and **Ed Tru**, Nancy and **Dave Wadleigh**, and Carol and **Al Wilson**. Plan to join us next year. Additionally, for Technology Day, we were joined by Louise and Dick Muther, John Glacken, and Nadja and **Vernon Winn**. **Harold Strauss** had been scheduled to be with us, but on the flight from Los Angeles he did not feel well (he had a heart attack 13 years ago), so he was taken off at Las Vegas. Good news is that within a day he felt fit as a fiddle.

Your 50th reunion committee has had a few meetings, with another scheduled for October 3. Plans are pretty well set. The dates to remember are June 1 to 5, 1988. In addition, before you read this, you should receive a new issue of Ed Hadley's newsletter. While the *Technology Review* goes only to those who have contributed to the Alumni Fund, Ed's letter goes to everybody for whom we have mailing addresses.

We recently learned that **Bill Gibson** passed away March 27, 1985. Bill had been in the Foreign Service until 1965, and lived in Alexandria, Va., where he got in a lot of sailing.

Richard Howe, who resided in Danvers, Mass. died February 25, 1986; no additional information is available.—**A.L. Bruneau, Jr.**, Secretary,

663 Riverview Dr., Chatham, MA 02633

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George Morrison, having retired from Turner Construction Co., continues near Peterborough, N.H., in a field he described loosely as "barnyard engineering." The field might refer to a 20-plus-acre part of the estate, but George didn't detail the "barnyard" part. Goerge said there is no generally-recognized neutralizer for New Hampshire's mosquitos, but it helps to have open fields on the farm or to travel to faraway places. George and Marge completed travels through India and Indonesia; and also China and Tibet, parts of which, at elevation 13,000 ft., left them a bit breathless. Their next trip is scheduled for autumn 1986 to Alaska and return through EXPO 86. Hopefully, they'll have time to meet classmates in the Pacific Northwest who find their scenery breathtaking.

Barry Graham phoned from a nearby paradise home at Seabeck, Wash. owned by **Astie** and **Hans Bebie**. They had completed clamping in the Hood Canal under the blue sky at 80° F and were about to drive 80 miles southeast to the Bebie chalet on the ski slopes of Mt. Ranier. Barry plans travel this autumn to Australia and New Zealand and said he is enthusiastic about attending 50th reunion.

Aaron White devotes time to consulting on micro metallography and swimming at a nearby club where, now and then, he meets classmate **Jerry Gross** who is microbiologist at Mass. General Hospital. Aaron said Silvia and **Seymour Sheinkopf** are considering a move to Maryland. . . . **King Cummings** is chairman of the board at both Sugarloaf Mountain Corp. and Guilford Industrial in central Maine.

We are saddened by news of death of two classmates. **Lawrence Cavendish** during March at Harwichport, Mass.; and **Thomas B. Akin**, during November at Marbella, Spain.—**Hal Seykota**, Secretary, 1415 Seaciff Dr., N.W., Gig Harbor, WA 98335

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Although your secretary is still battling his illness (cancer), with the skill and dedication of the people at the Dana-Farber Cancer Institute in Boston and a strong faith in Almighty God, I will succeed. Unfortunately, there were not notes available for the August/September issue. Can't let this happen again!

Had an enjoyable telephone conversation recently with Admiral **Peter V. Colmar** (retired U.S. Coast Guard), who took "final retirement" approximately 11 years ago from Boeing Aircraft in Seattle, Wash. I'm sure those in Course VI-A, as well as others, will remember him. Peter retired in 1963 after 34 years of continuous service with the U.S. Coast Guard, and immediately went to work as an electronics engineer for the Lawrence Radiation Lab of University of California, Livermore. He later joined Boeing Aircraft in Seattle until final retirement. He and his wife, Marjorie, live close to the harbor so he can still sail his 26-ft. boat whenever possible with his son, Stephen. The Colmars also have a married daughter, Carolyn. Peter plans to make the 50th reunion.

Bob Hess writes that he recently retired after 20 years with IBM. He celebrated by taking a six-week trip to New Zealand, Australia, and Fiji. He is so busy since retirement he wonders how he ever had time to work—home computer (IBM, of course!), ham radio, sailing, scuba diving, golf, catching up on reading, travel and. . . if he can find the time. . . taking up painting. Who said retirement can be dull? . . . **Bill Osmun** writes that he recently authored a book on history of Radio Technical Commission of Aeronautics, *The Authority of Agreement—A History of RTCA*, published in November 1985. . . . Chairman **Henry E. Single-**

ton of Teledyne, Inc. recently caught Wall Street by surprise when he announced at a recent annual meeting that he is relinquishing the post of chief executive to president George A. Roberts. However, no one expects any changes since they have worked so closely over the past 20 years. This California company, at present, has far-flung agglomeration of 135 divisions in dozens of industries. In addition, Teledyne is one of the most effective asset management companies in the nation.

More sad news to report. From the Alumni Association I learned of the death of **John R. Wuehrmann** on February 24th at his home, 26 Turtle Creek Dr., Tequesta, FL 33458. No other information was available.—**Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030, (617) 785-0540

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Raymond C. Foster, Jr. has been appointed Chairman of Stone & Webster, Inc., New York.

... **Edmund F. Dandrow**, Fairfax, Va., died September 15, 1985. His wife Mary E. Delgado and a daughter survive. It was great to see **Ivor W. Collins**, class treasurer at the 45th looking great. He wrote a marvellous letter from which I quote: "We did stay in the Dorm (New House) until Sunday, sight seeing and visiting friends in and around Boston. . . . Certainly good to see so many of the old gang well and able; not surprising that many are in their second or third careers. **Joe Gavin** will carry our flag high as president of the M.I.T. Alumni Association. For myself, I'm completely retired from any professional connections. Left GE in 1983 after 36 years, 25 of them in the missile guidance business in Pittsfield, Mass. Many of my friends have also retired and that business, like so much of GE is changing so fast, I would not recognize it if I went back there. I do a little volunteer work for the Research Triangle International Visitors Center, arranging appointments for visiting politicians, educators, and other professionals. I have helped in the Volunteer Income Tax Assistance program of the IRS, filling out forms for the elderly/poor at no charge. Three children all well: son 35, just moving to the NYC Transit Authority after many years at GE; daughter, 32, economist at United Way head office in Alexandria, Va.; youngest son 29, civil engineer with ConRail in Philadelphia. Red Coats in '91."

This letter will remind many of you of your solemn promise to send your class secretary a similar letter.—**Joe E. Dietzgen**, Secretary, P.O. Box 790, Cotuit, MA 02635

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As announced in the August/September notes, there were some survivors of the mini-reunion at Hawk Shaw's farm in New Ipswich, N.H., and we did get a run down about the goings on there. Edie and **Frank Seeley** arrived in style in a rented car chauffeured by Stempf using an authentic Australian driver's license. **Charlie (Stempf)**, according to Hawk, covered all of the state of New Hampshire with his usual swift efficiency and managed to depart before the State Troopers even knew that he had been there. Apparently all hands lunched at the Greenville Inn, and Seeley charmed the management with improbable M.I.T. tales so that they broke out a free bottle of champagne in honor of the historic occasion. Again, quoting from the gospel according to Shaw, Stempf complained that the champagne was really very poor U.S.A. stuff compared to that brewed in Australia.

Stempf, at some time in his checkered (or as they spell it "chequered") career, was a travelling sales manager for a Sydney publishing house. His territory included South Africa and he has sojourned in just about every motel and boarding house in every city boasting a bookstore and al-

lowing travelling pitchmen in. He reports no discrimination. Again, via the Hawk Shaw report, that must be true beyond all doubt since they let Stempf stop in in the first place! Finally, again from Hawk, the M.I.T. Club of New Hampshire is prospering mightily. Both he and our classmate, **Mort Goulder** are on its board of directors.

Jim Littwitz retired from Kodak after 40 years as a chemist in emulsions, assignments in plant management and doing sundry other executive chores at Kodak Park. You will recall that he was a record setting chairman of the Alumni Fund a couple of years ago and along the way has been chairman of the board of Rochester General Hospital, Rochester Mental Health Center, Northeast Health Center; is currently chairman of the Hemophilia Center of Rochester and a director of the Rochester Jewish Home. Upon retiring, he became consultant and manager of the newly organized Non-Profit Advisory Service sponsored by the Rochester Area Foundation. Jim will provide "needs analysis" to non-profit organizations in the local area. He certainly is a natural for this job and we wish him the best of success.

John Whitman, a non-retiree, is greatly enjoying his job in the Defense Intelligence Agency working on Strategic Defense Programs which is just one more bit of his 44 year career in air and space defense matters. He tells us that "the action has not been in our court for over 20 years," and implies it is finally our turn and about time at that. His oldest son received a Ph.D. in linguistics in June from Harvard. A lengthy and interesting article in the March 1986 issue of *Power Engineering* magazine is by **Allan Katzenstein**, our acid rain expert. It says that the link between SO₂ emissions and the acidity of rain is far weaker than generally presumed and that the link between acid rain and ecological damage is even weaker and nearly non-existent. I'm not about to get in the middle of this brouhaha, you all can step up, pay your nickel and take your choice.

Sadly, two obits this month, both from Course XV: **Dick Russell** who was general manager of Michigan Seamless Tube Division in South Lyons, Mich.; and **Eliot Reynolds** who lived in Southfield, Mich.; and worked for Chrysler Corp. Our condolences and sympathy to their wives and families.

I am writing this as we recover from the invasion of ten or 15 million tourists (depending on whose figures we use) who came to town to celebrate the Statue of Liberty Centennial. It is the hottest day of the year here and we wish all a happy and healthy summer.—**Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, NY 10605

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There has been some concern among my correspondents as to whether the Tulsa newspapers print items about foreign countries. To make sure that I was up on current events, **Dick Feingold**, **Israel Lenzner**, **Greg Gagarin**, **John Ward**, and **Jim McDonough** sent me word about the election of **Virgilio Barco Vargas** as the new president of Colombia. Through the courtesy of these classmates I now have a collection of clippings from the *New York Times*, the *Washington Post*, and *The Tech*. I wrote a letter to Virgilio on behalf of the class, congratulating him and offering him our best wishes.

John Ward also wrote that **Dick Fallows** retired from Mitre early this year and has been building a year-round addition to the family summer place at Biddeford Pool, Me. For himself, John says that he is still plugging along at M.I.T. with a program in Advanced Television Research, sponsored by a consortium of broadcasters and manufacturers. He wishes he could see more classmates at the Technology Day festivities in off-years. A National Academy of Sciences release states that **Robert L. Letsinger**, professor of chemistry at Northwestern University, is one of 59 new members chosen by the Academy. Election to membership in the NAS is considered to

be one of the highest honors that can be accorded an American scientist or engineer.

Two obituary notices have also come to me. **John G. McMullin** died April 9 in Newport Beach, Calif. He is survived by his widow Harriet, and a son. On April 26, **Hugh Pastoriza** passed away in Bronxville, N.Y. He leaves his wife Nancy, two daughters, a son, brother Jim (M.I.T. '48), and sister Dorothy (Mrs. Howard M. Bollinger). Howard wrote that among those attending the memorial service was **Howie Heydt**. We mourn the passing of these classmates and extend our sympathies to their families and friends.

In case nobody has mentioned it lately, the 45th reunion is less than two years away. Gentlemen, start your engines.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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Our mailbox continues to bring reports of more retirements: **Don Axon** retired at the end of 1984 after 31 years with Ford. He and wife, Shirley, are "doing a little traveling and dabbling in languages to fit our travels." They went to Portugal last spring, and Italy this spring. He remarked that he was "more concerned with the declining dollar than the terrorists, but together they should thin down the crowds." **Paul Ely** retired after 23 years directing the activities of the marketing research department at the Miller Brewing Co., division of Philip Morris, Inc. at the Milwaukee headquarters. He was awarded the Philip Morris Silver Ring Award for outstanding achievement and contribution. He has also been involved with community and professional activities. He and wife, Maryjane, (former secretary at M.I.T. to George Marvin, prof. of analytical chemistry) are building a home in Stuart, Fla., and will live there starting in the Fall of 1986.

Al Litchfield, '46, found familiar '44 names from Camp Crowder days listed in the *Tech Review*. He is interested in our mini-reunions and issues an invitation to classmates passing through Camden, Maine, to call or visit. After graduating in 1946, he was employed by Chance Vought Aircraft of Stratford, Conn., then moved to Dallas, Texas, in 1948. He has lived in Arlington, Texas, for 30 years until his retirement two years ago when he and his wife moved to Maine. Two sons remain in Texas and a daughter is working in Keene, N.H.

Regarding our next mini-reunion, we expect to have more definite plans for one by the next issue. At this point, bids are out for Michigan or California for the fall of 1987.—**Andy Corry**, Co-secretary, Box 310, Hyannisport, MA 02672; **Louis Demarkles**, Co-secretary, 53 Maugus Hill Rd., Wellesley, MA 02181

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By the time you read this it will have all been said and done—the 40th reunion, that is. But you'll have to wait until the January 1987 issue to get all the fascinating details. Meanwhile there are a few odds and ends to pass along.

The most notable and sad was the passing of F. Curtis Canfield, our redoubtable V-12 Commander. Curt had been ailing for some time and finally succumbed June 8th at the Cooley Dickinson Hospital in Northampton "after a brief illness." A graduate of Amherst, he began teaching there a year later, in 1926. As you may or may not recall he was a drama teacher, at Amherst for 28 years; first dean of the Yale School of Drama for another 13 years; and finally professor of theater arts at the University of Pittsburgh. He wrote two books on Irish drama, a book on play directing, and one of the founding of Amherst. He was 82. Would that we could all live so long. At ease, Commander, sir. **Mort Bromfield**, a V-12 naval architect who went on to get his masters in Course XV in 1951, gave a lecture on "Telecom-

communications Privacy and Our Freedom" at the Boston Public Library this past May. Mort heads up The American Privacy Foundation and lives in Wellesley Hills. . . . Little did I know when I mentioned **Keith Lanneau** in the May/June column that he had been a very busy man indeed! Just got a couple of press releases about the Helix International Corp. of Baton Rouge, La., where Keith is president. He has signed a cooperative research agreement with Louisiana State University resulting in University Agrinetics to research, develop and market technologies with commercial potential. Keith's company has advanced biotechnology expertise in animal and plant genetics and aquaculture. The article goes on to cite three pending projects which are quite impressive. But this is only part of it! Turns out Keith has been in various kinds of research ever since graduation (in physics). He has published technical papers in several scientific fields and holds 15 U.S. and foreign patents; he was awarded the Senior Moulton Award by the British Institution of Chemical Engineers, and was named "Outstanding Small Businessman of the Year" by the Federal Small Business Administration in 1965. Now, he's a guy I'd like to talk to.

Phil Bowditch retired in February from the Draper Lab where he had been chairman of the Lab's patent committee. Phil was honored in a ceremonial party during which among other things, Dr. Laning, head of the Automation Technology Dept., noted that "Phil taught me two very important precepts. . . . don't go to sea, and don't drink gin, and by all means don't do both simultaneously." Anyhow, if I read the Lab's newsletter correctly, it looks like Phil was replaced by **Dave Hoag**. Nothing like "keeping it in the family." **Tom Williams**, a Plains, Pa., product who survived the V-12 Course II grind, is "still building a law practice as sole practitioner in Bethesda, Md., living in nearby Potomac.

Lastly, a bit of sad news, which you probably won't have heard unless possibly at the reunion, is that **Gerome Gordon**, a former "neighbor" of Prez **Jim Goldstein**, had died in August 1985, at his retirement home on Johns Island, S.C. Unfortunately bad news doesn't always travel fast. Take a moment and let me know "where you're coming from." —**Jim Ray**, Secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

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Bill Katz has been executive vice-president and manager of the Water System Division of Ionics for the past seven years. Ionics has been very successful providing complex systems to purify brackish water. The treated water is suitable for drinking. The systems are sold world wide with most sales coming from arid, desert areas and islands. The process of purifying the water involves a membrane and application of an electrical force across the membrane. Bill has four children: one daughter is on the staff of *Newsweek*. She writes on sports and medicine and had a part in a cover article on calcium deficiency. Another daughter works with emotionally disturbed, underprivileged children. One son is at Union College, and another son at Mount Herman prep school.

Bob Sandman received responses from 90 classmates with suggestions for planning our 40th reunion. In May at a committee meeting the responses were reviewed. Attending the meeting were Bob, **George Clifford**, **Harold Ottobrini**, **Stanley Abkowitz**, **Verity Smith**, **Milton Slade**, **Sony Monosson**, **Mal Reed**, **Al Seveille**, **Don Noble**, and yours truly. There was unquestioned support for a reunion, but approximately 101 proposals for location, theme and the date of the reunion. There was general support for making up our minds early so that people can plan to be there. Our class has had successful off-campus reunions, and our 25th which was on-campus was a fantastic five day event. Personally, I felt we were past the point of considering options and had to start taking firm planning steps. After

heated debate, lengthy expression of positions, and other characteristics of democracy in action, the committee voted to have the reunion based at M.I.T. with some activities in the Cambridge/Boston area. **Harold Ottobrini** and **Sony Monosson** will determine what hotel arrangements are possible. Since a number of classmates have written to ask that we make provision for keeping their costs to a minimum, we plan to have a more organized effort in this area such as enabling visiting classmates to stay at the homes of classmates near Boston. On the other hand, it was agreed that events should be planned to be first class with the degree of elegance appropriate to the activity.

A mini-reunion of '47, '48, and '49 was held before Tech night at the Pops. Ira Dyer, '49, is on M.I.T.'s faculty in ocean engineering. He described his trips to the Arctic for research purposes. Frank Hulswit, '49, retired from A.D. Little. He and Sonya have visited the Great Wall in China as part of their travels. Claude Brenner, '47, told me about a development project with a system to reduce fuel consumption of vehicles. Among '48 classmates, the conversation was about the Reunion Committee's recent vote to have our 40th Reunion in the Cambridge/Boston area. Attending the reunion from our class were **John Brady**, **Stanley Chao**, **Mal Reed**, **Don Noble**, **Milton Slade**, **Bob Sandman**, **Vince Vappi**, **Graham Sterling**, and yours truly.

Jean and **Warren King**'s daughter Joanne has been executive director of a family health center in Chicago. During her three years of leadership, the facility tripled in size. She was responsible for a budget in excess of \$3 million annually. Joanne and her husband are moving to the Boston/Worcester area. . . . **Bob Gates** returned to the corporate office of Northrop Corp. in the new position of senior vice-president/International. For the past five years Bob had been on special assignment as the vice-president of the program for the F-20 Tigershark, a candidate for the Air Force's air defense fighter. He will now focus on the company's international marketing strategies for the Tigershark. . . . **George Keller**, chairman and CEO of Chevron, will serve on a federal advisory committee to the Secretary of Energy. The advisory committee has been asked to analyze the events and factors leading to the energy crises of the 1970s; to evaluate the vulnerability of the U.S. to future energy crises; and to examine "the factors affecting the nation's future supply and demand of oil and gas." . . . **Milton Pohl** is an assistant vice president at Merrill Lynch.

Bill Spiller died suddenly last year in King of Prussia, Penn. Bill's days at M.I.T. were interrupted by three years as a navigator in the U.S. Air Force. He worked for Scott Paper Co. for 20 years as a chemical engineer. Most recently he was a real estate broker. Our sympathy to his three children, his father, and his sister who survive him. . . . **Art Renz** died unexpectedly in Westport, Me. Art was a U.S. Navy veteran of World War II and a co-founder of N.H. Industries, a manufacturer and supplier of precision pulleys for elevators and other applications. Art was planning his retirement from active management. Our sympathy to his wife, Barbara, and their three children. . . . **Calvin Wong** died last year. He had been living in Livermore, Calif. Our sympathy to his wife, Alice, and their five children. . . . **John Murray** died in January of this year. He had been living in Pocasset, Mass. Our sympathy to his wife, Helen. —**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02860

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Received word from Professor **Nathan H. Cook** that he and his wife, Collie, have retired from M.I.T. where he has been on the faculty for 33 years. Nate is an active consultant, based in their home in N. Eastham on Cape Cod—a wonderful place to live, says Nate.

Jack A. Daley has been elected vice chairman

of the Connecticut National Bank. Jim was executive vice-president in charge of the bank's corporate services group. He joined the bank in 1968 as vice-president of data processing at the Hartford headquarters. He was promoted to senior vice-president in 1970. Jim is also a director and corporator of Hartford Hospital, as well as chairman of the hospital's audit committee, a trustee of the Hartford Graduate Center, a member of the executive committee of the Hartford Downtown Council, co-chairman of the Hartford School Business Collaborative, and a director of the Hartford Trust Co. of New York. He formerly served as president of the New England Automated Clearing House Association, chairman of the Greater Hartford Convention and Visitors Bureau, director of the Greater Hartford Chamber of Commerce, a member of the executive committee of the Connecticut Bankers Association, president of the Chatham Township (New Jersey) Board of Education, and a member of the Simsbury Board of Education. He and his wife, Alice, are the parents of four children and six grandchildren. **Harry Tecklenburg** general manager of Norwich Eaton Pharmaceuticals, a division of the Procter and Gamble Co. based in Norwich, N.Y., won the 1986 American Institute of Chemical Engineers' Marketing Division Award, which was presented to him in April. A Procter and Gamble staff member since 1952, Mr. Tecklenburg received the award for his achievements in the development, management and marketing of new soap, paper and pharmaceutical products. In 1952 he accepted a chemical engineering post in Procter and Gamble's process development department, responsible for manufacturing soap products. He advanced to group leader of the department in 1954, and to manager of manufacturing and product development for the company's paper products group seven years later. In 1970, Mr. Tecklenburg was named vice president of the research and development department. Six years later he was appointed a senior vice president charged with the company's world-wide research and development activities. He held this post until 1984 when he was selected to head up operations at Norwich Eaton Pharmaceuticals.

We regret to announce the death of **Howard P. Hayden** who passed away on April 27.—**John T. McKenna, Jr.**, Secretary, 9 Hawthorne Pl., 10-H, Boston, MA 02114

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A few months ago I reported that **Harold McAleer** was a group vice-president in charge of GenRad's Design Engineering Group, and stationed in England. Subsequently, the group was reorganized out of existence, and now Harold is a mere senior vice president again, with responsibility for Far East business strategies. . . . **Milton Dietz** is another senior vice-president, at Polaroid this time, who has had his title changed, from senior vice-president, engineering, to senior vice-president, strategic planning and corporate development. . . . **Richard Prugh** has made a more drastic career change. He has retired from DuPont after 30 years, and has founded Hazard Reduction Engineering, Inc., specializing in chemical process safety analysis. . . . **Anthony Jamroz**, formerly vice-president for U.S. Transmission Sales at Northern Telecom, is now president of Telco Systems Network Access Corp., a subsidiary of Telco Systems, which makes telecommunications products and systems.

Arnie A. Kramer has written me a nice letter to jog my elbow about our upcoming 35th reunion, which will be held on the West Coast next year. **Dick Heitman** is the reunion chairman, and Arnie suggests that Dick will need help, and will receive any offers with gratitude, especially, I suspect, if the pledges are carried out. Arnie says he considers himself a late bloomer, since he and his wife Roz have two sons aged six and seven. With life at sixes and sevens keeping them young, and tired, the family needs its long summer vacation

on Martha's Vineyard, and manages a couple of other vacations during the year also, but the permanent vacation of retirement is foreclosed by the prospect of future college tuition payments.

Thirty-five years! Can it be so long? Perhaps **Elizabeth King**, with eight grown children, finds it easier to believe than I do. An article from the Brunswick, Maine, *Times Record* describes her practice of architecture, after a career raising a family, in Woolwich, Maine, and Cambridge, where she is part of Advanced Environmental Group. They have invented a holographic device for directing sunlight into the interior of buildings. The invention recently won a \$5000 prize from Boston Edison Co., and the group is trying to develop and market the idea. Reading about it inspired me to invent an improvement: in addition to sunlight, the hologram could project a 3D image of the boss, to warn the help away from the water cooler and back to their desks.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301

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I received a short note from **Michael D. Stanfield** telling us that he's retiring early from Exxon after 30 years with that firm, the last 11 of which were in the Corporate Planning Department in New York City. Mike and his wife, Jeanne, have moved to Florida, where their son, Chris, is completing his senior year in high school. Their other son, Mike, Jr., graduated from St. Leo College, near Tampa, Fla., while daughter Mary Elizabeth is a senior at Villanova and majoring in finance. Good luck on your retirement, Mike, and let us know what your new avocations/vocations are.

Another retiree, **Guy D. Peverley**, left FMC a year ago and is now enjoying golf, water and snow skiing, while he does some consulting work on the side. Sounds like Guy's life in Wyoming is going great. . . . Some time ago, I quoted an article about **Betty Ann (Ferguson) Lehmann**'s change of professions. I just received a note from her which confirms that she is now the associate minister of the Federated Church of Hyannis, having been ordained in the United Church of Christ last December at Riverside Church in New York City. She also served one year as a resident chaplain at Columbia Presbyterian Medical Center in New York. . . . Finally, we have been notified that **John G. Polk** was promoted to the position of president, packaging sector, for the American Can Co. in Greenwich, Conn.—**Wolf Haberman**, Secretary, 41 Crestwood Dr., Framingham, MA 01701; **Joseph M. Cahn**, Assistant Secretary, 289 Bronwood Ave., Los Angeles, CA 90049

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A veritable plethora of news, relatively speaking, is available this issue. Let's get to it.

Hugh Nutley sends word that he was a NASA faculty fellow at JPL, Cal Tech, this past summer, his second such appointment. He was working on extreme value theory as applied to solar flare cosmic ray flux and fluence. . . . **Perry Smoot** is at the U.S. Army Materials Technology Laboratory in Watertown, Mass., working on boron carbide/magnesium metal matrix composites. His son, Frank, was married last month. . . . **Paul Gray** traveled to Houston last spring to tell the good folks there how they could learn from the Boston experience about overcoming economic downturns. Paul spoke at a symposium attended by some two hundred business, academic and government leaders from Houston. . . . Last March, *Business Week* ran a feature article on Henry Crown and Co., a "financial empire" located in Chicago. Given prominent coverage in the article was **Charles "Corky" Goodman**, who is vice-president of the company. Corky is given much credit for the company's success, having been born "with nothing but brains," according to a quotation from a "rival."

Joe Blake scouted around the Boston area and has sent along a few bits of news. Natalie and **Bob Warshawer** now have their second grandson. Bob recently conducted seminars in Lowell, Mass., and Philadelphia on "Selection and Implementation of an Automatic Project Management System." Natalie has prepared an exhibition of etchings scheduled for presentation this month in Worcester. Their son took third place in the Western 100 Mile Endurance Run last spring. Joe himself now has three grandchildren, two girls and a boy. Joe reports that he and Eileen take their oldest granddaughter with them on all of their trips.—**Edwin G. Eigel, Jr.**, Secretary, 33 Pepperbush Ln., Fairfield, CT 06430; **Joseph P. Blake, Jr.**, Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

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Several members of the class of '55 have made their careers at M.I.T. and I thought it would be interesting to feature, in my every-other-month column for the next year or so, the profile of one such classmate at the Institute. My west coast co-secretary, surprisingly enough since he does not work at M.I.T., found a way to be featured first!

It is with great pleasure that I announce the election of **DuWayne J. Peterson, Jr.**, to membership on the M.I.T. Corporation. Its members include some 90 distinguished leaders of industry, science, engineering and education and (ex officio) the M.I.T. president, the treasurer and the secretary of the Corporation, three representatives from the Commonwealth of Massachusetts and the president of the M.I.T. Alumni Association. Wayne was one of eight new members elected this year for a five-year term. He will be serving on the Corporation Development Committee and will undoubtedly be in touch with some of you in that role.

I am also pleased to report that Wayne has a new position as executive vice-president for Operations Systems and Telecommunications at Merrill Lynch and Co. This position is described in the *New York Times* as "a new position at the financial services concern that amounts to its communications czar." As chief technology officer at Merrill Lynch, Wayne will be responsible for guiding the development of advanced systems worldwide. A spokesman said that operations personnel in various branches of Merrill Lynch would report to Mr. Peterson and that part of his assignment would be cost control and organization of the use of technology in the various units. Wayne and Nancy are off to Norway for a vacation and should be settled into their new apartment in Manhattan by the time you are reading this. It will be nice to have them back on the east coast but we will miss our west coast coverage.

Daniel P. Kiser reports that he is the owner and manager of a limestone quarry and ready mix concrete operation in Drumwright, Okla., and he and Mary Lou enjoyed the 30th class reunion. We hear from **Victor M. Tyler II** that he has relinquished his title as president of Concord Computing Corp. in Bedford, Mass. but continues to retain his chairman and CEO titles.

Warren Lattof arrived in my office last spring for a quick visit and lunch at Walker Memorial. He and Charlotte resettled to a new house in Arlington Heights, Ill. For years, prospective buyers called them regularly in hopes of buying their extra lot. They finally sold it with their house and bought a smaller home which they renovated to their needs. It overlooks 20 acres of natural land where they enjoy viewing the wild life, including deer; but Warren complains because he commutes 20 minutes instead of 2 to work now. Their sons, Michael, and Alan are on their own—Alan graduated from Colorado College, married in '82 and made grandparents of Char and Wa Wa when Samantha arrived eight months ago. Alan is sales manager at Lattof Motors. Elizabeth will be a junior at the University of Vermont next year and is going to Nepal in conjunction with her major in

Asian Studies. Warren, president of Lattof Motors, in March of '86 was honored as one of 12 Chevrolet dealers to represent the over 5,000 Chevrolet dealers at a General Motors Advisory Council meeting. They met with the president, vice presidents, and board members of GM for several days to give them the perspective from the field. Warren and Charlotte travel regularly with groups of GM dealers from the US and Canada and spent several weeks in China last fall.

Keep the news coming!—**Robert P. Greene**, Eastern Co-secretary, 37 Great Rock Rd., Sherborn, MA 01770; and **DuWayne J. Peterson, Jr.**, Western Co-secretary, 201 East 79th St., New York, NY 10021

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Greetings. The summer doldrums have hit and consequently I have received only a few items for inclusion in this month's class notes. A newsy note from **Gerry Katz** reads: "I've been with Witco Corp. for twenty-one years with the exception of a one year leave in 1979-80 to join Bear-Stearns' Merger and Acquisition Department. Witco is a \$1.5 billion worldwide manufacturer and marketer of specialty oil, chemical and fabricated engineering products. The company has grown ten-fold in both sales and profits since I joined it in 1965. I've held numerous positions including vice president and general manager of our polybutene division, vice president and general manager of our oil and gas division, and have headed up Witco's corporate development and acquisition program for a number of years. I have recently been promoted to group vice president chemicals and am responsible for the operation of six Witco divisions including Richardson Battery Containers, Inorganic Specialties, Witco France, Witco Israel, and Witco England. These operations account for approximately \$230 million in sales. For the past four months I've been travelling throughout the United States and overseas getting acquainted with the people, the markets and the opportunities. I'm looking forward to my new assignment. My wife Annbeth has just been appointed manager of personnel for the corporate headquarters of Grand Met USA. Six years ago she received her M.B.A. from Pace University, Westchester, N.Y. We have two daughters: Jill, a sophomore at Cornell; and Debbie, a freshman at University of Michigan.

Hal Laeger writes to inform us that he is one of a minority in our class who have turned their backs on technology (small "t"). He's spent his career in marketing and advertising and is president of Nacht/Laeger Advertising, a New York ad agency. He goes on to say that Tech has given him a certain facility in understanding and helping their hi-tech clients. His older son has decided to pursue a broad education and keep his options open by enrolling at Harvard in the Fall.

A recent note from **Dick Krock** along with a \$25 check for his class dues and requesting a copy of the 25th reunion picture/biography book was a welcome surprise. For those of you who may be interested in obtaining this piece of memorabilia, just drop me a note and include a check made out to M.I.T. Class of '59 to the address below.

That's all the news for this month. Please let us know what's new with you so we can keep our consecutive issue streak going (we're aiming for Joe DiMaggio's record of 56 straight). Regards.—**Art Collias**, Co-Class Secretary, 24 Hemlock Dr., Canton, MA 02021

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Keep in mind that next year is our 25th reunion. I'm not sure who's in charge, but you should receive some info in the mail. **Jerry Adams** has made a dramatic change in career. He is now a financial consultant for Merrill Lynch in Baltimore; he used to be a physics professor at Roanoke College. . . . **Robert Anderson** has been

appointed group vice-president for semiconductor test at GenRad, Inc., with responsibilities for operations in California and a product line in Massachusetts. . . . **Glenn Buckles** completed his M.B.A. at Dartmouth and joined Booz Allen and Hamilton's consulting practice in Washington, D.C., specializing in strategies and technology planning for the aerospace industry. . . . **William Childs** is mentioned in a company newsletter as executive vice-president and co-founder of EESof, Inc., in California. . . . **Chuck Gerheim** writes that he, his wife JoAnn, and son Timothy (5), are moving to Saudi Arabia, where he will be general manager (technical) for Saudi Petrochemicals Co., a joint venture of Shell Oil and the Saudi Basic Industries Council. . . . **Leland Jackson** reports that he got smart and is no longer department chairman in electrical engineering at the University of Rhode Island. His book, "Digital Filters and Signal Processing," has been published by Kluwer Academic Publications.

Harold Metcalf was selected outstanding innovator in 1985 by *Science Digest*. . . . **David Spencer** is chairman of Data Recording Systems, Inc.; he founded the company in 1983. He and his wife Pam report that Mark (15) is attending Lawrence Academy, and Scott (12) began junior high school this fall. . . . **Raymond Wenig** is busy developing artificial intelligence expert systems applications in the areas of sales, marketing and financial planning. . . . I received a nice letter from **Bob Wilhelm**, president of Esso Inter-America. Due to company reorganization, he and his family are moving from the Miami area to Short Hills, N.J., where he will be executive vice-president of a newly formed division of Exxon, in charge of all its international oil and gas business. Bob, along with his wife Donna, Lara (6), and Nicholas (3), will miss the weather and lifestyle of Florida, but observes that he may now be able to attend our 25th Reunion (although it clearly has not really been that long since we graduated).—**John E. Prussing**, Secretary, 2106 Grand Dr., Urbana, IL 61801

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You like to find out how your classmates are doing? Well, they'd like to know about you, too. Please take a few minutes off from raking up leaves and putting up the storm windows to write a note or phone me.

I am pleased to pass on an announcement from **Marty Schrage, Ira Blumenthal, and Pete Van Aken**: They've formed a new company in Woburn, Mass., called Xanalog. They are apparently consultants in computer systems for continuous dynamic simulation. These guys should do well in this area—I recall their continuous hydrodynamic simulations of warfare in Baker House some 25 years ago. . . . **Harold Solomon** reports that he met **Larry Renger** last summer in Tokyo. Larry was working on a joint venture in new toy development. . . . I have a note from a newspaper clipping service, abstracting the *Wall Street Journal* of March 10 to the effect that **John Castle**, already president and chief executive officer of Donaldson, Lufkin and Jenrette, Inc., was elected a director of that company.

Steve Colburn, who chairs the department of biomedical engineering at Boston University, has been honored by that institution. In April he received the Award for Excellence in Memory of Duncan MacDonald (founder of Itek Corporation). . . . Steve stayed at M.I.T. after receiving his Ph.D. in 1969, until he moved to B.U. in 1980. The award cites his research in auditory systems, applying theories of signal processing to the study of hearing and its impairments. . . . An amiable note has arrived from **Elliott Bird**. He tells us, "It's been a tough year for running. I developed sciatica a year ago after running several races. Had to cut down a great deal. Have entered the Long Island, N.Y., Half Marathon—will I finish?" Elliott is a consultant in four public school districts, and he teaches math at the C.W.

Post campus of Long Island University. His son, a ninth-grader, won a gold medal at the Long Island Math Fair. His wife Toby received her Ph.D. in English from C.U.N.Y., after studying under Irving Howe.

I close with a note received from Donald Gudehus, '61: "I was saddened to read of the passing of **Allen Tunick** in *Technology Review* (Feb./March 1986). We played first clarinet together in the Concert Band from 1958 to 1961. I have fond memories of the many band trips we took back then, including one to the winter carnival in Quebec City. In 1963 I was living in San Francisco, and he called me from Berkeley, where he was a graduate student in chemistry; it was a pleasant surprise. I later moved to Los Angeles and we lost touch. His death at such a young age is an unfortunate loss to all who knew him." If there is some positive teaching from such untimely mischance, I suppose it is that all we have are our friends, with whom we should stay in touch.—**Phil Marcus**, Secretary, 2617 Guilford Ave., Baltimore, MD 21218, (301) 889-3890

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I regret to start off with sad news. It is that our classmate **Jeanne Horwitz Fertel** died on March 9, 1986. She graduated in Course VIII and then received a Ph.D. in astrophysics from M.I.T. in 1969. Jeanne made her home in Hawaii after leaving Cambridge and was extremely active in community affairs and politics. The impact of her involvement is indicated by the passage of a resolution in her memory by the Hawaii House of Representative. Jeanne is survived by her parents, Mr. and Mrs. Clarence Horwitz, and her sister, Leslie Horwitz Lynn, '71. On behalf of all of us, I extend our condolences and sympathy to Jeanne's family.

The bulk of the news this month comes from news clippings and Alumni Fund notes. **Bruce Hopkins** was appointed general manager (retail packaging) by Champion's retail packaging business in Walden, NY. The plant in Walden employs 325 people. Bruce joined Champion in 1978; before that, he earned an M.B.A. from the Tuck School at Dartmouth. Bruce and his family reside in Ridgefield, Conn. . . . **Drexel Burnham Lambert** announces that **Bill Young** joins the firm as a managing director specializing in the chemical industry. Bill recently was listed by *Institutional Investor* as the number one chemical analyst—for the seventh year in a row. . . . **Bob Colomb** writes that he expects his Ph.D. in computer science from the University of New South Wales shortly. He recently joined the Information Technology Division of the Australian Commonwealth Scientific and Industrial Research Organization, in charge of advanced software research and development. Bob's personal news is that he is still single. He also says that he is "finally becoming respectable"—but he doesn't say whether that's personally or professionally respectable.

Our first class secretary, **Ron Gilman**, is the 1986 president of the Society of Memphis Magicians. He continues to practice law in Memphis, is teaching a Saturday class in trial practice at the Memphis State University Law School, and has chaired the M.I.T. Education Council Region for the past 17 years. . . . **Patricia Page Wilcox** moved to the Columbus, Ohio area last year with her husband John. She's staying busy working at Online Computer Library Center and "keeping up with five acres of back yard, a big garden and a new Amiga." Their number one daughter is off to college at Dartmouth. . . . Several days before receiving the latest batch of notes from the Alumni Association, Louise and I were doing some house painting. After creating some particularly messy drips, I referred to them as "apple gunkies"—the "sponsor" of WTBS's Saturday night all-request radio program. Sure enough, among the latest batch was a note from **Jeff Michel**, who served WTBS well as an announcer/disk jockey during "our years." (The radio sta-

tion's call letters are now WMBR.) Jeff has entered a new area of activity—economic and political research on the German Democratic Republic (East Germany). His first article appeared this summer in a magazine published by the West German Social Democratic Party. Jeff hopes to be publishing in this country soon, as well.

I'll close with news of three of my former roommates. I crossed paths at Logan Airport with **Gary Walpert**, who was off on a trip to New Jersey to do some patent lawyering. He is working hard and enjoying life at his new firm, Hale and Dorr. . . . **George Piotrowski** called with news that he's taking a sabbatical from the University of Florida to devote more time to his consulting firm, Design/Analysis Services Co., specializing in engineering analysis of automobile and aircraft accidents. . . . **Jerry Weiner**, our classmate the travel agent, was the major focus of an article on hidden-city airline ticketing which appeared in a number of newspapers, including the *Washington Post*. Jerry is being sued by American Airlines for \$96,000 for lost revenues. I'll not take the space here to describe hidden-city ticketing—see your local travel agent for details. . . . Louise and I have taken up golf with a passion. We just returned from an extended weekend business meeting in Williamsburg. Heavy-duty management stuff, delicious food, great weather—but the best part was the golf. Louise figured out the secret to getting a respectable score: All you have to do is know on which hole to stop. Send a note with news of yourself, career, family, and especially any tips you may have on how to cure a slice.—**Joe Kasper**, Secretary, 3502 Idaho Ave., NW, Washington, DC 20016

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Gary Rose writes that he has left Boeing and moved back to the New York area to take a position as vice-president for operations of Icarus Computerized Consulting Service, an aviation consulting company. Gary and Sandi have three children—Kristin, 17; Jeff, 14; and Kari, 3. Sandi has taken a break from her business as a travel consultant to raise Kari.

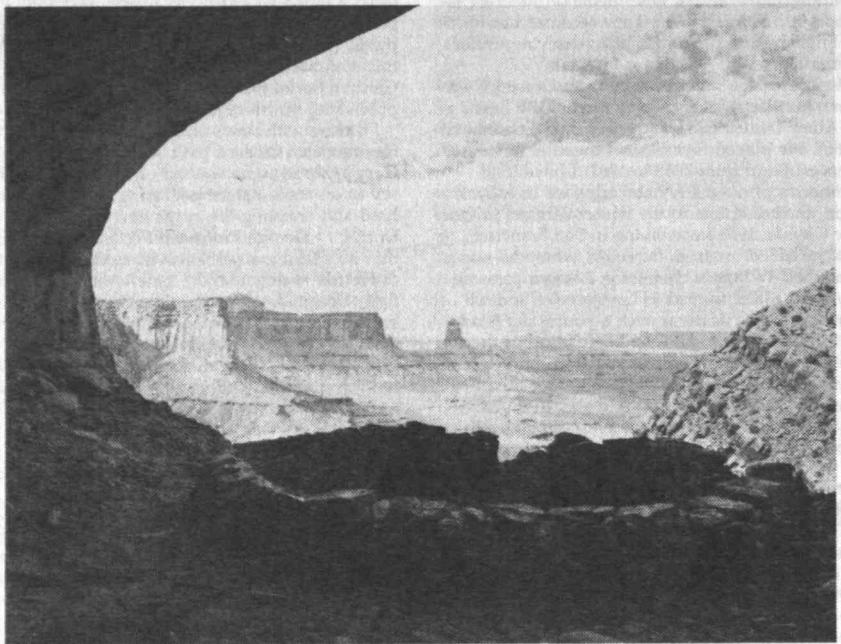
Several press releases and clippings have arrived reporting that **Regina Hertzlinger** has been named the Nancy R. McPherson Professor of Business Administration at the Harvard Business School. She has been at the business school since 1971 and a full professor since 1980. Regina is the first woman to be appointed to an endowed professorship at the business school and the second to be named full professor. Her research has been in the area of financial control of nonprofit institutions and the American health care industry.

I've received a bit more information about **Jim Hartman**, whose death was reported in last month's column. Jim received his M.S. from Nebraska in 1967 and his Ph.D. from Case Western Reserve in 1970. He joined the faculty of the U.S. Naval Postgraduate School in 1970 and was an associate professor of operations research there at the time of his death. Jim and Gisela were married in 1970 and have one son, Stephen, who was born in 1973.

It would be refreshing to have a bit more news to report next month. Please write.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

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As I write, the 20th reunion has just ended. Many thanks are due to Stu Vidockler and his committee—**Fred Webb, Ralph Schmitt, Gerry Degnen, Terry Cronburg, Matt Fichtenbaum** and **Joe Rife**—for a job well done. Stu is already collecting ideas for the 25th reunion. Give him a call if you have suggestions. . . . Appreciation is also due **Joe Shaffery** for his work as class secretary. I hope I do justice to the position during the next five-year term. If you've sent some news and



For obvious reasons, "The Kiva" (above) is a favorite photograph of Jeffrey M. Reynolds, '69. Reynolds works in Yakima, Wash., as a family practitioner and pathologist, but photography is a principal pleasure—the result of his studies with the late Professor Minor White at

M.I.T. Reynolds has two portfolios—editions of 20 each—and books based on them, and he also turns his photography to public service through projects such as a photographic calendar of "Yakima 1986" to benefit Yakima Neighborhood Health Services.

haven't seen it, please send it again, because we appear to have lost some items in the transition.

Paul Lafata writes that he is a partner with Ernst and Whinney, an international accounting and consulting firm. He lives, with his wife and two children, in Houston, Tex. . . . Those of you interested in computers might enjoy reading "Hackers." The first third of the book describes many events and people at M.I.T. during our years there.—Jeff Kenton, Secretary, 7 Hill Top Rd., Weston, MA 02193

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I am very short on news this month. Please write! Or, if you prefer, give me a call at (415) 948-4914 (home) or (408) 988-2211 (work). I do enjoy hearing from you. Within the next month or two I should have further details on our 20th reunion set for June 5-7, 1987. Plan to attend.

David Schramm, professor of astronomy at the University of Chicago, is one of 59 individuals elected to membership in the National Academy of Sciences at its annual meeting in April. . . . John Broadley left the general counsel's position at the Interstate Commerce Commission in June 1984 and entered private practice with the Washington D.C. office of the Chicago firm of Jenner & Block. He specializes in transportation law and litigation.—Jim Swanson, Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

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Just across the Potomac from where I'm typing these notes into my new Macintosh Plus (which gives me a prayer of a chance of finishing my book in the next 90 days), I can imagine Jerrold Levinson speculating on matters metaphysical.

contributions to the theory of estimation and detection in stochastic systems and to their application. . . . The April 14, 1986, cover of *Reflector* features Genentech C.E.O. Robert Swanson. The article says "President Raab recently left Abbott Laboratories to team up with C.E.O. Swanson to help commercialize cofounder Boyer's revolutionary gene-splicing technology. Their goal: to make Genentech a \$1 billion-a-year drug company by 1990."

Keep those notes comin' down heah to Old Ginny.—Eugene F. Mallove, Secretary, 11902 Paradise Lane, Herndon, VA 22071

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Wesley Moore and family took a trip to Europe, including stops at Stockholm, Paris, and London. He suggests that any other classmates traveling ought to take their own garbage bags. . . . Audrey Solomon Kadis writes that she is a financial counselor at Wingate Capital Corp. in Lexington, which specializes in investment management and tax planning. She and her husband, Jack, who is an investment banker, have two children. Joshua is in kindergarten and is learning LOGO, and daughter Jessica (4) prefers bicycles to computers. Audrey attended Harvard Business School and previously was involved in the financial service industry. . . . Sandy Harlow announces the birth of his third son. He now can look forward to family doubles in tennis, foursomes in golf, and two-on-two in basketball. Sandy's two older boys are twins, who keep his spouse Marilyn very busy. The family moved into a house 50-years-old and is involved in remodeling and decorating. Sandy is a marketing specialist with Procter and Gamble's Paper Division, specializing in retail marketing at the supermarket level. Sandy informs me that Terry Michael has started his own business in Pittsburgh, Technology Home Health Care. Sandy looks forward to the 20th reunion. . . .

Rick Walleigh lives in Los Altos, Calif. and writes that he still indulges himself in playing basketball. After playing basketball for the M.I.T. varsity team, he became an engineer in the Boston area. He married Wendy and got his M.B.A. from Harvard Business School. In 1974 he and his spouse moved to California where he worked for Kaiser Steel as a financial analyst. After that he went to Hewlett-Packard. For the last ten years he has held a variety of positions in financial, engineering and production management. His family now includes two children, Adrian (9) and Diana (7). Rick has become a recognized expert in the field of "just-in-time manufacturing," a technique which originated in Japan. His article on this subject appeared in the March-April issue of the *Harvard Business Review*. He is now a manufacturing consultant in the San Francisco Bay area for Arthur Young and Co. using modern manufacturing techniques. Rick writes that Larry Kelly and his wife also live in Los Altos and have two children. About two years ago Larry started his own company, which makes add-on products for Hewlett-Packard computers and personal computers. Larry's company is small but is doing very well.—Robert Vegeler, Secretary, Beers, Mallers, Backs, Salin & Larmore, 220 Fort Wayne National Bank Bldg., Fort Wayne, IN 46802

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Our 15th reunion was a rousing success. From Tech Night at the Boston Pops to our dinner and dance on Saturday night, a good time was had by all. The other events shared by all of the alums of various classes attending the reunion should be publicized elsewhere in this or other issues. I will concentrate on the activities of the members of our Class that attended the reunion and on a description of Saturday's dinner and dance.

The password at the cocktail hour was: "I don't know anyone here." Although the faces were familiar, the reunion was well represented with

people from all courses and all living groups. As a result, we all had to introduce ourselves to each other and get to know each other.

The cocktail hour and part of the dinner were spent in conversations about jobs, careers, children, vacations, and computers. Most of our classmates are cleaner, more prosperous, and have shorter hair (either by nature or by design) than they did in their student days.

Everyone seemed to be less serious about themselves and life than when we left in '71. This was exemplified when **Bob Terwilliger**'s sweet soul music echoed through McCormick Hall. We relived the sixties and the seventies as we danced the night away. I was able to impress my wife with all the smart people that were my classmates. I have been telling her how smart I am for the last 12 years and now she finally believes me. The members of the reunion committee present at the reunion were **Bob Terwilliger**, who is presently the owner of a 32-room house in Wellesley and is considering remodeling; **Ray Seakan**, who is president of Citadel Locks, Stoughton, Mass.; and **Phil Smith**, who is a product specialist for Tera-dyne and is a translator for sales between the customers and the factory. Phil and his wife Susan have two children, Damon (7) and Jerod (4). The only female member of our class brave enough to attend was **Sally Harvey** who is an in-house management consultant for Digital Equipment. Others attending the reunion were **Peter G. Hwang** who is manager of product marketing at Aida Corp. in St. Clara, Calif.; **Timothy J. Malony**, Ph.D., who is a staff engineer at Intel Corp.; **Kevin R. O'Brien**, senior assistant analyst, communications branch of Sperry Corp., McLean, Va.; **Bill Birthsel**, development engineer for WCI Controls & Data Systems in Rockford, Ill.; **Philip Martel**, programming and consulting with ProCon, Pittsfield, Mass.; **G. Chris Marlor**, manager, technical/engineering systems & management information services with Dreser Construction Equipment Division, Broadview, Ill.; and **Michael F. Linehan**, member of the technical staff, Communications Systems Division, GTE Government Systems, Needham Heights, Mass. Mike and his wife, Martha (Gordon College '73) have two sons Matthew (3) and Mark (11 mos.). Also attending were **Paul Funk**, **Donald L. Estes, Jr.**, president of Applied Software Ergonomics, Inc., Melrose, Mass. (a former Texan); **R. Dale Zellers**, project engineer, formerly with Med-Tronic, Inc., now enjoying (Geodesic) Domestic life, Parker, Colo.; and **Peter Lindner**, who completed his M.B.A. at the Sloan School this year in management information systems and will be working and living in Cambridge. Peter had lived in New York City for the last twelve years.

Phil Isenberg, 5 Tennyson Ave., Dover, NH 03820, a research scientist at the Space Science Center, University of New Hampshire, studying solar wind and space plasma physics; **Jerry Namery**, with Winchester Systems, Inc., heads a four year old start up company that makes software development work stations; **Craig Richardson** who is working in the data base group at Wang Labs and is living in Amherst, N.H.; **Donald G. Roth** was formerly with Exxon and has recently gone into the software business with Don Estes. He and his wife, Maureen, have three children. **Del Knarr**, 1112 Beryl St., #6, Rodondo Beach, Calif., is currently assistant engineer for big projects. His previous jobs have been maximizing marginal return. His philosophy is Rolling Stones, beer, baseball, sun (in whatever order is convenient) and his hobbies are Rolling Stones, beer, baseball, sun (in whatever order is convenient). His goals are to retire as soon as possible with his stereo (to play the Rolling Stones) to a place with beer, baseball and sun (in whatever order is convenient). **Zane Segal** is a writer/video producer. **David Laing** now lives in Montreal and works in video productions and also works with helping abused children.

Although they didn't attend the reunion, I met some members of the Class of '71 and other classes (who are all former DELTS) at dinner.

These include **John T. Dieckmann** who is with Arthur D. Little, Inc., **David Crary** who is regional sales manager with Gould Electronics, **Bob MacCready** who is with a jewelry company as a CPA, **George Hustack** who is with Associates for International Research, and **Jim Shields** who does important work for an electronics company, but whose card I either lost or didn't get.

The Institute did a great job of providing numerous activities for the reunion. To those of you who did attend, it was good to see you, to meet some of you for the first time, and to renew old friendships. For those of you who did not attend, start saving and planning for our 25th reunion. The 25th reunion is when M.I.T. really rolls out the red carpet. With a little planning, we can make it be very special for everyone. Our class is looking for its officers. I am secretary, but I have no record of who our president, vice-president, or treasurer are. I wish those of you who hold those offices would write me and let me know who and where you are. I am currently taking the responsibilities of treasurer (which are slight), but I would like to find someone who would like to become treasurer if the treasurer's name is lost to history. If you are interested, please write me. I need your help.

In other news, **James L. DeLucas**, M.D. has recently completed a second residency in aerospace medicine at Brooks Air Force Base. After graduation in June, Emma, Larry, Sandi, and James moved to Wright-Patterson Air Force Base in Ohio where he will be assigned to the Aero Medical Research Lab.—**Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

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Stanley Albrecht has been promoted to vice-president of Martin Marietta Denver aerospace, in charge of production operations including manufacturing, product assurance, system safety, material and mission success. . . . **Steve Perrenod** writes that he finished his Ph.D. in astronomy at Maryland in 1977 and did three years of post-docs (at University of Illinois and Kitt Peak Observatory in Tucson). Steve then switched to the computer field and has been at Cray Research since fall 1983 as a senior marketing analyst in Pleasanton, Calif., near the San Francisco Bay. On February 2, Steve and Yuriko Fukazawa got married in Hakone, Japan. . . . **Ken Kempson** is a proud father of not one, but two lovely babies, a boy and a girl. . . . **Bonnie Kellermann** continues to do a great job of running the M.I.T. Educational Council and is always on the lookout for more alumna members. Bonnie and committee have started planning our 15th reunion—June 1987 is drawing near. Bonnie also reports the following: After more years than we can remember, **Bob Ebert** has received his Ph.D. . . . **Richard Weissberg** finally tied the knot with Barbara Kivowitz. The happy couple, after some planning is ready to set off on a year or so jaunt around the world. . . . **Linda Mayeda** has changed jobs (again) and is now working for General Computer (at least at the time of this writing). . . . **Joe Edwards** and **Janie Matrisciano** have a baby.

Riccardo Dicapua and his family have moved to the States. . . . **Adnan Akant** and his wife Alison (Wellesley '77) moved to New York two years ago from Washington D.C., where he was with the World Bank. He is now a partner at the investment firm of Charter Atlantic Corp. Alison is an Assistant district attorney. . . . **Charles Gronauer** is an architect in Palm Beach Gardens, Fla. He is chairman of the 1987 annual state convention of the Florida Magicians Association. . . . **Kathy Kram** is beginning new research on ethics and values in corporate decision-making. She continues to teach at B.U. School of Management and to consult for organizations on a variety of human resources management concerns. . . . **Robert Richmond** started a company two years ago, Active Voice, Inc., which is now distributing its first product through G.T.E. It has been hard

work he says: "We have a long way to go, but it is fun." . . . **Mark Linsky** and his wife Roberta have decided after four East Coast winters to return to California. While east they "gave our 5-year-old daughter Sheryl a brother Matthew; Roberta experienced East Coast computer companies as a senior human resource manager at Wang; and, as vice-president of engineering for V.C.N. in Kendall Square, I tried my hand at developing software products for the I.B.M. P.C. After reviewing several exciting opportunities on the West Coast, I decided to return to Hewlett-Packard to get involved in the Spectrum program. We plan to close our stay on the east coast with a ten-day, bareboat sail in the British Virgin Islands on a 50-foot sailboat with three other couples; what a way to go." . . . **Cher** and **Marty Shinko** had a daughter, Kelly Marie, about a year ago. Marty has been doing hotline support for computer simulations related to energy, nuclear power and electric utilities at Control Data. He has also been taking an artificial intelligence seminar. Both parents are thoroughly enjoying the baby.

Stephen Chessin wrote a real long letter with lots of news of classmates. Last November, he went to Nicaragua as part of a technical aid mission organized by TecNICA, a Berkeley-based group. He worked with the Ministry of Finance and visited a coffee coop at Matagalpa and sebaco. His overall impression is "that Nicaragua is a really beautiful country and it's too bad that our government is trying to overthrow their government." In January, **Paul Hirsohn**, who is still with Harris, drove down from Berkeley to see Steve's slides. Steve has bought a condo in Mountain View, remains single and politically active, and "resists becoming a yuppie." I.B.M. gave Steve a Director's Award for his role in the development of Academic Information Systems 4.2, one of the two operating systems for the I.B.M. R.T. P.C. This is being used on M.I.T.'s Project Athena, which brought him back to the Charles. While revisiting old haunts he also had lunch with **Steve Henry**, who is doing patent law. Steve Henry, Carol and their three kids are living in Marblehead. Steve Chessin also reports that he saw Marcie and **Bob Peterson** and their son Thomas in Seattle last September. Bob is still with Boeing, and they were building a house. Debbie and **Duane Lindner** hosted their annual cookie swap in December. Their 10-year-old son John was there, as were Margie and Lenny Pfister and their kids, and Lindsay and **George Pavel**. George is in Livermore at Lawrence Livermore National Laboratory; Lenny is with NASA Ames, and is living in Sunnyvale; Duane is at Sandia Laboratories. Finally, Steve asks when exactly our 15th reunion will be. It will be early June 1987.

Having recently returned from a great trip to Peru, I have no travel plans until I go to Expo and a cousin's wedding in August in Vancouver. Work has slowed down due to restructuring being forced by the tax bill. Hopefully there will still be some fun project financings to be done by the time you read this. Meanwhile, send more news and have a great fall.—**Wendy Elaine Erb**, 531 Main St., Apt. 714, New York, NY 10044

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A few items to share with you. **Paul Bayer** celebrates ten years of computerizing weather at W.I. Corp. in Bedford, Mass. He, wife Terry, and children Andy, Megan, and Joanna live in Westford. . . . **David Simen** and his wife celebrated their third anniversary in May with their two children. He is enjoying systems engineering at Bell Labs. . . . **Robert Parks** is on the working group for the Daedalus project, a human-powered flight experiment.

Ruth and I leave in two days for a week in Salt Lake City at the SPEBSQSA convention, hoping to help the Alexandria, Va., chapter win its first championship. My quartet, the Portsiders, finished seventh in a field of 29 at the last divisional contest, after only three months together. It's

now five months, and we'll get 'em next time. Write.—**Robert M.O. Sutton, Sr.**, Secretary, Chapel Hill, 1302 Churchill Ct., Marshall, VA 22115

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Many apologies for missing the August/September issue. I thought things were supposed to slow down in the summer but that was not the case for me this year.

My favorite letter this issue is from classmate **Matt Farber** because he encloses a marvelous picture of himself riding a camel, with the pyramids in the background, during a recent trip to Alexandria, Egypt. Matt had been assistant professor in the Department of Ophthalmology and Community Medicine at the West Virginia University Medical Center in Morgantown, W.V. for two years. He served as head of the retinal service and was principal investigator for a laser study as well as for the West Virginia Diabetes Eye Care project. He was also invited to serve as a visiting surgeon on Project Orbis, a jet plane outfitted with an operating room for eye surgery, and it seems the plane took him to Egypt. In June, Matt joined the staff of the Santa Barbara Medical Foundation Clinic, Santa Barbara, Calif. According to Matt, his most exciting news of the past year has been the arrival of his first son, Aaron Daniel, on November 22, 1985.

Sandra Kelly Fillebrown writes that she and husband Steve had a baby boy, Scott Russell, in July 1985. They recently bought a home in Philadelphia. Sandy expected to finish her Ph.D. in math in June 1986 at Lehigh University and will be teaching at St. Joseph's University as of this fall. . . . **Christine Cowan-Gascoigne** was recently named director of marketing at the Cleveland Clinic Foundation. She had her first child, Lela, on July 15, 1984, and was expecting her second in June 1986. . . . **Roy S. McKenzie** and wife Alice are enjoying their son Alex (I). The McKenzies were expecting another child at the end of the summer. Writes Roy, "My career has changed tracks, moving from quality assurance to director of management information services for Scott Laboratories." He often sees Charles Garberin, '60, and is continuing his service to M.I.T. as an educational counselor. . . . **Andrea Reyman Hiner** and husband Michael are living in Slidell, La., a suburb of New Orleans where they both enjoy working at Shell Oil. Says Andrea, "The oil industry is mean and lean these days, but that makes exploration and production work that much more exciting. We've recently been blessed with a new arrival—Rebecca Lee (our first). Welcome friends, guests, visitors—any time." See you at Mardi Gras.

More news: Since October 1985, **Mitchell G. Tyson** has been product manager for the Wafertrac product line at G.C.A. Corp. He says he's "having lots of fun battling through the recession in the semiconductor industry." . . . **William C. O'Neill** is currently assistant professor of medicine at Emory University School of Medicine. . . . **Kenneth M. Deemer** has formed a private venture capital partnership with four others. He and his partners are raising a \$35 million fund for investing primarily in high technology companies. Ken was married in September 1985 to Candy Kuelin. They honeymooned in Greece and Egypt. Ken is involved with CalTech in the M.I.T./CalTech Enterprise Forum. . . . **Lydia E. Talmers** is working for Digital Equipment Corp. in Dallas, Tex., and loving it.

P. Michael Jung was named partner in the firm of Strasburger and Price in Dallas, Tex., in March. After M.I.T., he went to Harvard Law School, from which he graduated magna cum laude in 1979. Before joining his present firm, he worked as a law clerk for Patrick E. Higginbotham, who was then U.S. District Judge for the Northern District of Texas. Michael's practice now includes appellate and trial litigation. . . . **Jeffrey H. Lang** was the 1986 recipient of the Harold F. Edgerton

Faculty Achievement Award. This award is given annually to an M.I.T. junior faculty member who has made outstanding contributions to research, teaching and service to the M.I.T. community. Jeff received his Ph.D. in E.E. at M.I.T. in 1980 and was then appointed assistant professor in electrical engineering and computer sciences. In July 1985, he was promoted to associate professor. His accomplishments are too numerous to report here, but as an example, his undergraduate students in an electromechanical dynamics course he instructs call him the best teacher they have had at M.I.T. . . . That's it for now. Please continue to keep in touch.—**Jennifer Gordon**, Secretary, c/o Pennie and Edmonds, 1155 Avenue of the Americas, New York, NY 10036 (or 18 Montgomery Pl., Brooklyn, NY 11215)

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It is my deep sorrow to report the death of **Gary Tyler**. I would like to quote from a letter written by his father. "Gary perished in a small plane crash on May 26, 1985, in Argentina. He had just started an assignment there that week for G.E. Four people—two German nationals, one Argentine woman, and Gary—rented a small plane for a recreational trip to Igazu falls approximately 500 miles away. On the return trip they encountered clouds and approaching darkness as they neared their air field. One of the German nationals was the pilot and was not instrumented rated. Apparently he became disoriented and even though they were in radio contact with the field, they crashed just 12 minutes from their destination. There were no survivors. . . . After graduating from M.I.T., Gary worked for Arthur G. McKee, who build processing plants and was assigned to an iron ore briquet processing plant in Venezuela. One year later, he went to work for G.E. in their Installation and Service Engineering International Division. In this service capacity he traveled all over the world on varied assignments. For several years he spent time on and off oil rigs in the Persian Gulf, China Sea, and also off the coast of S. America. . . . On one of his earlier assignments he worked in Kuwait. While there, Gary and another G.E. engineer inadvertently strayed over an undefined and debatable border in the desert, between Iraq and Kuwait. They were incarcerated for several months in Iraq, incommunicado, and neither Kuwait nor the U.S. authorities were notified of their captivity. Weeks later, Gary smuggled a message to a Kuwait official who came to the Iraq prison to bring back some of the Kuwaiti citizens who were imprisoned there. Eventually, through the mediation of the Belgian consulate, they were released. . . . Gary enjoyed his work very much, and I might add, was good at it. His G.E. manager tells us he wished he had all clones of Gary. Even though he was given the option of managing the company's service offices in Venezuela, Singapore, and Bahrain, he chose to continue going out on assignments in his current professional capacity. I believe that Gary had plans to eventually teach at one of the G.E. schools or else at M.I.T. . . . Needless to say, this untimely, tragic loss of ours was devastating. We have established a grant for scholarship at Gary's high school and also at the Catholic school whose church Gary attended and belonged to. This is a memorial to him that I know he would have approved of."

Also from the mails: **William (Bill) Menke** "earned the Presidential Young Investigator Award (1986), and accepted assistant professor position, Dept. of Geological Sciences, Columbia University, starting in the Fall, 1986." . . . **Andrew Hawryluk** is "now at work at the Lawrence Livermore National Laboratory in the Inertial Confinement Fusion Program. My wife, Ann Mansfield, is a pediatrician in Modesto, Calif., where we now live. We just had our first daughter, Amy Michelle, born Oct. 31, 1985."

Sam Price writes, "Kathy and I are expecting child number two in June." . . . Also, **Bob** and

Judy (nee Leider) Lambe are delighted to announce the arrival of Rebecca Jane on February 28, 1986. Becky was welcomed by her brother, Andrew Thomas, age 4, and sister, Jennifer Lynn, age 2."

We have an update from **John Nagerani**: "Following a brief stint as one of their (Actualizations, a human potential movement) staff persons in San Francisco, just long enough to get a good look behind the facade, I moved to LA where I sold Hi-Fi for a while, then returned to engineering with new-found enthusiasm and effectiveness. After a near-fatal motorcycle accident, I seized an opportunity to become a design manager for Phone-Mate where I eventually became responsible for all new product development. After a year and a half there, I got fed up with its irresponsible management and managed to get myself fired. After some time spent re-evaluating my direction, and a few stillborn efforts, I landed a job as a consulting engineer in Santa Barbara, where I am now working hard, rebuilding my reserves and preparing for future exploits. My few noteworthy achievements are a patent, co-authored, which boosts the effective bass output of the Bose-Delco stereo system (Dynamic Equalization); a ringer resonator design for American Telecommunications which became their standard; and a number of designs for Phone-Mate which were instrumental in jumping their sales from \$40 million to \$70 million in one year; including the model top-rated by *Consumer Reports* in May 1986. . . . If there is one thing I have to say from my experience, it's that it is no wonder that the Japanese are beating us in consumer electronics. Most of the management I have run into is either inept, lazy or corrupt; and most of the engineers I have met have just plain given up. . . . Of course, I have had my share of failures; just yesterday I took a fall on my bicycle resulting in a need for several stitches on one elbow; recently, I have had to shelf several month's work due to my own misjudgment; and I have yet to find a company management that makes it easy to feel good about working with them. It is getting to be just a matter of time until I get something started on my own."

From the *Hour*, a paper in Norwalk, Conn., we have learned that **Raphael Schein**, M.D. has opened an office for the practice of internal medicine in Wilton, Conn. Previously, for over two years, he had been a staff internist with Community Health Care Plan, a Bridgeport-based HMO. Raphael, after the 'Tute, went to Albert Einstein College of Medicine and interned at the Norwalk Hospital and University of Miami-affiliated hospitals.

As for your secretary, he hopes to have reunion news available for subsequent notes, assuming that he is re-elected as Secretary. On the news front, I would like to quote from the social announcements section of the *N.Y. Times* of Sunday, May 25, 1986. "Rita and Arthur J. Carp of Forest Hills are pleased to announce the birth of Shana Lee, born May 21." Hopefully, our daughter will be in the class of '07 or '08.—**Arthur J. Carp**, Secretary, 110-07 73rd Rd., Forest Hills, NY 11375; (718) 544-5136

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I am deeply saddened by news of the death of **Barbara Rosemark** in December 1983. At the time of her passing, Barbara had completed medical school and started her internship in family practice at U.C. Davis Medical Center in Sacramento. I would appreciate receiving any further information about Barbara.

My fellow 1981 Wharton alumnus **Steve Feldman** writes that after four and a half years with Arthur Andersen and Co. in the management information consulting division of their Boston office, Steve left in December to become the management information systems manager at the headquarters office of Symbolics, Inc., in Cambridge. Says Steve, "Symbolics is the leading

maker of symbolic processing (LISP) computers, and is crawling with M.I.T. alumni (and drop-outs!) of all types, so it's like old times. Many challenges are ahead. The other big event is my marriage to Debbie Lipson (Dartmouth '78) in April (in Detroit, of all places). Debbie is another ex-A.A. and Co. consultant, and now works in the management information systems department at Stratus Computer. . . . **Susan (Kaufman) Poulos** works for the North Carolina Alternative Energy Corp., a non-profit organization which promotes conservation, load management, and renewable resources. Her projects are in lighting and passive solar design. . . . **Ronald Dector** writes, "Still at work for G.M. Debbie and I are purchasing a house in Troy, Mich., and should be moving in one and a half months, before the arrival of our third and last child!"

Mike Patrick and Diane (Gorczyca) Patrick, '80, are, according to Mike, "continuing their odyssey in yuppiedom in their condo in Inman Square. A recent St. Patrick's Day party at the Patrick's brought together most of the alumni of the T.E.P. fraternity in the Boston area." . . . After getting his undergraduate degree in aero and astro, **John Langford** got his M.S. in defense policy and arms control from M.I.T.'s political science department. He has since competed in three model rocket world championships. John is a research staff member with the Institute for Defense Analyses and a grad student in aero and astro at the Tute, and is project manager on Project Daedalus, a proposed human-powered aircraft flight from Crete to Greece (69 miles) scheduled for the spring or summer of 1987. John has also been involved in two previous human-powered aircraft projects, the Chrysalis and the Monarch.

My very first M.I.T. friend, **Sharon Gardner**, participated in the M.I.T. telethon in May, and dug up a lot of dirt for me: **Andrew Robinson** and family (including an 8-month-old son) love Ann Arbor, Mich., where for the past few months he has been enjoying his assistant professorship. . . . **Mark Schaefer** got his master's in acoustics at Penn State and started in January as a senior research engineer with an advanced research group in medical ultrasound. In addition, he has his own consulting company, is working on a Ph.D. at Drexel, is happily married, and is tearing apart his living room to put in a fireplace.

Ronald Wexler got his Ph.D. at Berkeley in 1983 and did a post-doc at Caltech. He has been working for Kodak in Rochester since September 1985, and also is tutoring high school students in math and chemistry, enjoys ballroom dancing and cross-country skiing, and is "not married but looking" . . . **Craig Perry** is living in Needham Heights. . . . **Jim Thompson** got his master's in architecture at Carnegie-Mellon this past May. . . . Sharon also tried to reach **Mark Stern**, but he wasn't home.

A few days ago, Robert and I attended the wedding of Charles Mobbs, '78, to Zita Wenzel. Robert and Charles work in the same lab at Rockefeller University, so I was prepared to meet other Rockefeller people but forgot there was also an M.I.T. connection. Imagine my surprise to run into **Cindy Fry**, **Bernard Beard** (who acted as best man), Ken Kellogg, '78, John Small, '80, and his wife Mary Halm Small, '78. Cindy, who has been living in D.C. for the last year and a half working for a defense contractor, says she "destroys submarines for a living." She got her M.B.A. at U.S.C. in 1982. Bernard works in propulsion engineering for General Dynamics in Fort Worth.

Jose Perez worked for a defense contractor in D.C. for a while but is now back in the Boston area, directing the computerization of operations for a community-based senior citizens' social services organization in Somerville. . . . **Ginger Fitzsimmons** lives in Boston and is the mother of two, a boy and a girl. I am celebrating my fifth anniversary with Mobil, which means two things: first, I get another piece of Mobil jewelry—a stickpin sporting a 10 karat gold Pegasus and a ruby chip (for my first Mobil anniversary, I got the same pin but without the chip); second, and

much more importantly, I now get three weeks vacation! I am taking a week of said vacation and flying off to California. Robert is already at a conference in Anaheim. I will join him in two days and we will link up with Iris and David Beyer, '77, and their one-year-old daughter Elyse. We will spend a day at Disneyland, three days in San Diego and environs, two days in Phoenix (where the Beyers live), two days at the Grand Canyon, and then we will wrap up in Dallas, where I've got a business trip. While there, we plan to spend some time with Gretchen Megowen, '76 and her husband Mike Jung, '75. One of the best things about this vacation is that it will take us out of New York during the July 4 weekend, which promises to be a real madhouse. Hopefully the city will still be standing when we get back. Until next time.—**Sharon Lowenheim**, Secretary, 303 E. 83 St., Apt. 24F, New York, NY 10028

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As usual, thanks to everyone who wrote this month. It really is great to hear from people—and I'm sure frequent readers of the Class Notes appreciate hearing what you are up to.

Tom Griffin writes with lots of news about his life since graduation. He recently resigned his commission in the Navy after four busy years, nearly three of them on the nuclear cruiser U.S.S. Arkansas, mostly in the Pacific and Indian Oceans, where he served as a radiological controls and chemistry assistant. He has now returned to New England (after changing his address ten times in five years). He's back at M.I.T. now as a full-time Ph.D. candidate in chemical engineering. He and his wife Christine, will be living in Quincy. He's seen many M.I.T. alumni recently, though few from our class. He has, however, spoken several times to fellow-S.A.E. brother **Brian Abbarat**, who lives in Davis, Calif., works in the communications industry, and is busy studying part-time for his M.B.A. . . . **John Dolan** is now living in England and is kept busy as head of a petroleum process development group at Exxon. He travels often to the Continent and plans to be married soon. Tom points out that it's now been ten years since we were all together at the Freshman Picnic in Killian Court. Hard to believe, huh?

Charles Hoffman announces the birth of Richard Lipris Hoffman. Charles and his wife Linda Lepris (Hoffman), '82 are very excited. They recently bought a house in Wenham, Mass. He has just finished his Ph.D. thesis in molecular biology and microbiology at Tufts and will post-doc in the genetics department at Harvard Medical School (with Dr. Fred Winston). Linda works at New England Biolabs. Charles hasn't heard much from M.I.T.-types, but says that **Jean Wisner** graduated with a Ph.D. from Northwestern and recently married. . . . A long letter came from **Gordon Hunter** brings us up to date on his life since June 1980; I'll list the highlights here. He received his Ph.D. in metallurgy from M.I.T. in June 1984 and became postdoc running the Materials Science and Engineering Welding Lab for a while. He escaped from M.I.T. before becoming a faculty member by marrying Julia Irde, '84, in October 1985 in Coldwater, Mich., (her hometown), and moving to Cincinnati. The wedding party was full of M.I.T. people (mostly from the class of '84, plus Ed Hunter, '79). Gordon now works for G.E. developing new ways of processing metals to make aircraft engines. He's heard from several classmates: **Gary Engelson** moved to Worcester with his wife Jean and daughter Michelle. He still works for DEC. . . . **Jason Linhart**, **Scott Layson**, and **Brian Hess** are still running Mark-of-the-Unicorn (a software development firm) in Cambridge. **Craig Finseth** left the firm to move back to Minnesota. . . . **Glenn Clemen**, his wife Meg, and son Sean were living in Dayton where Glenn and Meg are in the Air Force—but they were supposed to move this summer to D.C.

Bruce Chung graduated from Wayne State

Medical School in 1984. He's now in his third year of a family practice residency, after which he'll go into the Air Force to "finally" pay back his R.O.T.C. commitment. . . . **Eric Pearson** spent four and a half years at Stanford in the Materials Science Department. He's now at the Pentagon working for the U.S.A.F. . . . **Richard Fastow** received his Ph.D. in physics from Cornell University and is now a post-doc at the Technion in Israel in the Department of Materials Engineering. . . . **Dorian Jankowski** is a resident in pediatrics in Salt Lake City, Utah, where she explores the unique beauty of southern Utah during every possible break from work. . . . **William Fraizer** is a senior chemical and process engineer for Chevron U.S.A.'s planned oil and gas processing plant in Western Santa Barbara County, Calif. He visits occasionally with **Walt Schumacher** and **Bruce Reynolds**, both Practice School classmates, who both live in the San Francisco area and work for Chevron Research in Richmond.

Christopher Vinger graduated with his Ph.D. in physics from Boston University and went to work for T.I. in materials science. After eight months he was assigned to work on expert systems and has just recently transferred to the Defense Systems and Electronics Group of T.I. to do image/signal processing. . . . **William Hunt** is a Ph.D. candidate in electrical engineering at the University of Illinois. His dissertation is on the surface acoustic wave properties of GaAs; he expects to receive his degree within the year. . . . **Alexander Bardow** went to work for Stone and Webster Engineering Co. in 1982 after receiving his M.S.C.E. In 1983, he took the position of assistant structural engineer with the Mass. D.P.W.'s Bridge Section, where he is still employed. Between the two jobs, he completed a slate model of the original Rogers Building, which he donated upon completion to the M.I.T. museum. The model is currently on display there as part of the Rogers Building exhibit.

Diane (Gorczyca) Patrick and her husband Mike Patrick, '79 now live in a condo in Inman Square. A recent St. Patrick's Day party brought together most of the Boston-area T.E.P. fraternity alumni. I saved this news for last because I, too, recently bought a condo and moved to Inman Square. In fact, I believe the Patricks may live downstairs but have yet to confirm this. I've been here only a couple of days and have been busy unpacking. I'm sure I'll know by the time this column is published, however! . . . In the meantime, have a great autumn, note my new address, and write, write, write.—**Kate Mulroney**, Secretary, 256 Hampshire St., #3, Cambridge, MA 02139

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Hello everybody. I hope you had a wonderful summer. If you didn't make it to the reunion, we missed you, and you missed a super time. We had about 150 people attending, with about 100 classmates present. The weather could have been better, but everyone seems to have had a great time anyway. The activities began Friday evening with an exotic island party. We had a 15-piece steel band and about 25 hula dancers. Saturday was an all-day whale watch; however, nobody was actually able to see any whales. Some classmates used the term "fog watch" to describe the day's activity, but it was fun anyway. Saturday evening was the cocktail party at M.I.T.'s Endicott House in Dedham. We all enjoyed good music, dancing, food and drink. Finally, Sunday was the class meeting and brunch at the M.I.T. Museum. During the brunch, **Chuck Markham** gave the "Class Presentation"—which provided a great deal of humor for all of those present. In all, almost two thirds of our classmates responded to Chuck's questionnaire; we'll certainly have to make it a tradition! During the class meeting we also elected a new slate of officers to serve us for the next five years—until our 10th reunion. Chuck was elected president, probably because his presentation was so entertaining. **Mitchell**

Brook, now a New York City attorney, is our treasurer. And **I, Lynn Radlauer Lubell**, will be responsible to pulling together the Class Notes as the secretary. In addition, we elected a number of regional vice-presidents: **George Dowd, Mike Gerardi, Dave Noble, Paul Miller, Bob Ashton, Walt Crosby, Cynthia Zannetos Peltier and Steve Solnick**. Nine vice-presidents may sound like a lot, but we are still looking for a West Coast representative. If you are interested, please let us know. **Marc Chelemer** will be our class agent and **Lynn Meradian** will be helping out from the West Coast. **Nick Adams** (remember Nom. Comm.?) was instrumental in putting the slate together and running the election.

Annie Laurie Murray and her husband Gus de los Reyes, '80 were at the reunion. Annie looked a bit heavier than usual: she and Gus are expecting their first child this fall. . . . A good-sized S.A.E. contingent was on hand for Saturday night's festivities. **Bill Fowler** is married to **Briette Netze** (Wellesley '81), and **Mike LaRow** is planning to tie the knot shortly. Mike has joined the suburban set with his new home in Sudbury. **Paul Marcus** and **Bobby Clarke** were also in town. . . . **Adina Gwartzman** just graduated from the Harvard Business School and has accepted a position with McKinsey. **Steve Achkenase**, is also with McKinsey, in their Atlanta office. . . . **Steve Meltzer** was another recent graduate of Harvard Business School.

We received a note from **Joe Maher**, who was recently promoted to supervisor of engineering for Blandin Paper Co. of Grand Rapids, Minn. Joe was married this spring. . . . **Bill Gardner** is designing digital synthesizers at Kurzweil Music Systems in Waltham, Mass. . . . **Heidi Harvey** graduated from Cornell Law School in May and will be practicing in Boston. . . . **Dave Venecia** graduated from the University of Washington School of Medicine last year. He's interning in Corpus Christi, Texas, and plans to specialize in emergency medicine. . . . **Beth Datskovsky** and her husband are the proud parents of a baby girl, Miriam Malka. . . . **Fran Hall** is teaching N.R.O.T.C. at Villanova and working on her M.B.A. . . . **Dave McClelland** is flying C-130s for the U.S.A.F. in North Carolina. He claims to be having a good time but would prefer to be in California. He writes, "Where's Ron LaSalvia?" A clue comes from the Navy, which sent us a press release saying that Ron recently received a Navy Achievement Medal for his work on submarine target motion analysis.

Lew Bender is manager of the chemical products division of Handy and Harman. Lew tells us that **Dennis Smith** is at Rutgers Medical School and that **Mark Bloomberg** is a Harvard Law School graduate currently practicing in New York City. . . . **Stephen Levin** made it back east for the reunion. He's having a great time in L.A. (much to his surprise), where he is working for Northrop. . . . **Jim Askey** married **Kathy Zorlov**; **Bob Pfeiffer, Eric Buckman and David Powsner** were in attendance at the wedding. . . . **Bill Flarsheim** may be needing a bicycle-built-for-two. While at a bicycle club meeting in Austin, Texas (where Bill is working toward his Ph.D.), Bill met **Georgia Hetzel**, a potter. They will be married next year. . . . **Joy Weiss** is learning to substitute her Canadian "eh's" for Southern "y'all's". She recently transferred from her native Montreal to Research Triangle, North Carolina, where she is a manager for Network's Technology.

Mark Fogel wins the prize for most creative marriage proposal. He put his proposal to **Rani Kulik** up on the electronic bill board in Times Square. It sure did the trick, as Mark and Rani were married on May 4th. Mark has finished his internship at Albert Einstein College and will be specializing in pediatrics. . . . While on the subject of M.D.'s who have recently married, **Mark Neimer** has tied the knot with medical school classmate **Yasyn Lee**. . . . **Laurie Ullman** recently married **Arnold Herman**. Laurie just completed her internship in medicine at St. Elizabeth's Hospital in Boston and will be pursuing a residency

in dermatology in Boston. . . . Now, onto the subject of M.D.'s who have not recently married. . . . **Nora Fong** and **Julie Neuringer** are both doing residencies in Dallas, Tex. Julie's in internal medicine and Nora's in ophthalmology. . . . **Rob Kirsch** recently graduated from U. Mass. Medical School. He'll be moving to Morton, Penn., for a four-year residency in radiology. Rob promises to make it back to Cambridge for our 10th reunion. . . . **Barbara Messinger Rapport** is finishing up the M.D./Ph.D. program at Case Western Reserve University in Cleveland, Ohio. In her spare time, she is training for a "Tin Man" triathlon.

Simon M. Peacock is an assistant professor at Arizona State University; he completed his Ph.D. in geology at U.C.L.A. in June 1985. . . . And now some news from the military. **George Biodyn** is with the Air Force in the Philippines as a pilot. **Stephen Fairbairn** has been promoted to captain in the U.S.A.F. He is on tour in England flying F-111s. . . . **Russel Roth**, also with the U.S.A.F. is a major and an assistant professor at the U.S.A.F. Academy in Colorado Springs. . . . **Deby Meadows Fouch** is also in the U.S.A.F.. She's currently at Columbus A.F.B. Miss., and has a beautiful house in the country. Deby is married to **Trent Fouch** and they have two children, Rachel (3) and Daniel (1). Deby writes that she loves being a mother, and she has news of some classmates: **Dianne Parry** is back at M.I.T.; **Sue Babcock** was married to **Todd Kelly** last September; **Michelle Lucier Glatz** lives in Charlotte with her husband Bob; **Nancy Bustian Hubingand** and her husband Todd live in Raleigh, N.C., with their two children. . . . **Tom Woofolk** is with Sperry Aerospace and Marine in Charlottesville, Va. He has two kids, Betsy (4) and Sid (2). . . . **Lisa Klien** says that she is pursuing the ministry at the Lutheran School of Theology in Chicago and is spending the summer in Turkey; she says hello to all her Bakerite friends.

Kumkum Mathur Dilwani is a consultant with Arthur D. Little in Cambridge, working on a hazard and risk assessment project. She says that she and her husband love Beantown and plan to say around for a while. . . . **Mike Gerardi** writes that he is at Georgia School of Law, after quitting his job at Rockwell. . . . **Eric Sohn** lives in New Jersey and works in Manhattan at Marine Midland. . . . If you have been stuck in traffic on the New Jersey Turnpike or Interstate 80, you might want to give **Paul Reim** a call. He has been involved in the "traffic mitigation" effort around the reconstruction. However, he'll be stuck in Boston traffic this fall when he returns to M.I.T. for a master's in public policy. . . . **William Topazio** is working for Editel, which he says is New York's best video post-production facility.

Homayoun Khalili writes that he is happily married and employed in Singapore. He and his wife **Minoo Pooya** send regards for a cold New England winter. . . . **Andrew Michael** married **Stephanie Ross** (University of Miami '82) last June. They live in Palo Alto with their two cats. Andrew received his Ph.D. in geology from Stanford last year. . . . **Dale Von Ruden** is also married and living in Palo Alto. Dale is with a film technology division of Arian Associates. . . . **Arthur Lee** has transferred out of the Air Force and is with I.B.M.'s Federal Systems Division in Sunnyvale, Calif. . . . **James Freidan** is president of Management Systems Research, which produces computer aided design systems for the printing industry. James married **Sara June** on June 4, 1983. . . . **Paul Miller** writes that he recently moved to Jackson, Miss., to run his father's construction company and fast food restaurant. He says that the hours are longer and the work less intense than his previous computer jobs.

Finally, a couple of business items: If you ordered a class directory and did not receive one, please let us know; if you did not order a class directory and would like to receive one, we have a few still available for \$8.10 (class dues)—please let us know. Also, copies of the class survey are available. Please send requests to me (must be accompanied by news for Class Notes)—no excuses

accepted), and I will forward them to Chuck. Please keep writing. Have a great fall.—**Lynn Radlauer Lubell**, Secretary, 216 Beacon St., Boston, MA 02116

83

Eva Wu has finally decided to put her three degrees to work at the Drama Studio at Berkeley, Calif. Eva graduated on May 31 with a degree in professional acting. Eva can now add this degree to her BSME, BSEE, and MSEE. Congratulations on a job well done. Let us know where you wind up. . . . **Mark Dulong** graduated from Brown University Medical School on May 26. He will begin residency training in plastic and reconstruction surgery at Stanford University in California. . . . **Chester Barry** is working for E.I. duPont as a field engineer on assignment at the petrochemicals department in the Old Hickory, Tenn., plant. Chester is in love with the life near Nashville. He says that he has not yet caught the marriage bug; however he does have two beagles. Chester says hello to Sam and Alex.

Heidi Tocker, who was in Thailand building toilets for the past two years, has now taken a new position in the U.S. Consulate in the same city of Udonrthani. Heidi's mom was adventurous enough to go and visit her in Thailand, however Heidi still needs our support in Thailand. Please drop her a line if you get a chance at the American Consulate, Amphur Muang, Udonrthani 41000, Thailand.

What column would be complete without a Celebrity 83 class member? This issue it goes to **John Piotti**, a very significant honor since he is the first repeat celebrity winner. John was awarded the International Balfour Award during Sigma Chi's annual leadership workshop at Kansas State University. The Balfour Award is given to the most outstanding senior from Sigma Chi's 187 chapters.

Things here in New York are going well. I am writing this column from California, where I'm taking a week's vacation and basking in the California sunshine with Garth Gehlback, '84. I have spent the last week playing tennis, golf, swimming, and running. I competed in the Eastern Corporate Track and Field Championships in White Plains, N.Y. IBM won the meet, and now we will be competing in the national meet in Los Angeles, Calif. It should be a fun time. Keep the letters coming, and be sure to note the new address.—**John E. De Rubis**, Secretary, 14 Charles Ave., Port Washington, NY 11050

84

Hello from your long-lost class president! Yes, I'm still alive and I haven't forgotten about you. It's so amazing how fast two years can go by. . . . I've already started my second job in industry, last April. I'm with TRW in Redondo Beach, Calif. I spend a considerable amount of time in Denver on travel and see Sarah Gavit, '83, whenever I'm there. One week I was in Los Angeles long enough, though, to discover that I sit down the hall from **Peter Rutherford** and **Eric Weaver**, '83.

I tried to dig up as much California dirt as I could for this column, so here goes. . . . **Ed Monuki** just returned from a month-long trip to Japan. He'll be starting medical school in the fall at University of California, San Diego. . . . **Vivian Wang** returned from the Vancouver Expo '86 just in time to go to the Alpha Phi Convention in San Diego with me. She'll be at Columbia next fall. . . . **John Inadomi** is still surviving medical school at University of California, San Francisco. . . . **Jackie Whang** is working for a biotechnology firm in Silicon Valley. . . . **Davin McAndrews** works for Lockheed and lives in the San Fernando Valley. . . . **Mike Battat** is working himself to death at Megatest in Silicon Valley. I saw him in Los Angeles recently at his brother's. . . . **Jeff Fried-**

man works for the same company as Jackie and will be starting medical school at Stanford in the fall. In the meantime he's vacationing in Europe. . . . **Scott Globus** is taking pictures in San Francisco. . . . **John Altman** is in graduate school in San Francisco. . . . **Ira Leventhal** is still with HP in Santa Clara. . . . **Nancy Beckman** is still with IBM in Silicon Valley. . . . **Bob Abramson** is still working in Los Angeles as far as I know. . . . **Phil Nelson** is in San Francisco working for a company called ADS. They used to be called AIDS, but Phil urged them to change their name. He and **Mike Cation**, also of ADS fame, are starting up their own company, sponsored by ADS. Sounds like they are doing quite well! Mike is still engaged, and travels to Texas whenever he can.

Jim Deasy is headed for San Francisco. . . . **Mark Brine**, '85 (my PLP big bro), is working in Silicon Valley. . . . **Kevin Soch** is vacationing for a month in Europe. . . . **Rob Pokelwaldt** just bought a brand new Porsche 944. . . . **Mark Farley** is dating a telephone operator in the Bay area. . . . **Dave Garcia** is vacationing in Mexico. . . . **Lisa Tener** is living happily in San Francisco. . . . Sources tell me that **Dan Battista** has really gotten into the southern California scene and has been tanning up and working out. He's looking pretty good (except he needs a haircut) and may be appearing in a *Playgirl* "spread" soon! Please form the line behind me!

In the rest of the world: **Mark Miles** is juggling two women in Boston. . . . **Lillian Chiang** will be moving to Memphis soon to finish up her Ph.D. I saw her in Los Angeles on her way back from Taiwan. . . . **Judy Chow** just passed her qualifiers. Congratulations! . . . **Jack Kelley** is at an air force base in Tampa flying jets. . . . **Ann (Clasen)** and **Jeff Berner** are in Seattle at Boeing. . . . **Mike Landmeier** is living in Phoenix. . . . **Pam Gannon** and **Ellen Williams** are both pursuing Ph.D.s at Tufts. Pam is in a summer internship at Woods Hole, and Ellen just returned from sunning in Cancun. . . . **Kathleen Harragan** is recovering from knee surgery. I hit the local drag club with her while she was in Los Angeles for a convention in February. Recently, however, she really let me down at a Yankee game at Shea Stadium, where she saw Matt Dillon and didn't give him my number!

Carolina Leonard got her master's and has a job with a small consulting firm in D.C. . . . **Laura Szytier** is bored in the Boston suburbs. . . . **Jono Goldstein** will be starting at Harvard "B" School in the fall. . . . **Via Valge** is at M.I.T. Practice School and a house tutor at MacGregor. . . . **Mark Radlauer** is at Tufts Medical School.

. . . **Chris Panagakos** is working on synthetic blood at a small start-up company near Tufts Medical School. She received her master's in chemical engineering from Stanford and is living happily on Newbury St. . . . **Eric Jaeger** works in Boston for a law firm called Fish and Richardson. I hear he has designs on law school. . . . **Laura Lesniewski** is working for an architectural firm in Central Square.

I received a postcard from **Sue Marinov** from St. Martin. She's still in Boston. . . . **Ned Gordon** is finishing up his master's at Northwestern. . . . **Steve Smith** was working in Texas but moved back to Boston. . . . **Tim Kneale** is in the second rotation of his job and no longer in North Carolina. . . . **Paul Gottschalk** is going for his Ph.D. in computer vision at the University of Michigan. . . . **Lyman Opie** is working as a shipwright and high school science teacher. . . . **Aron Judkiewicz** is finishing his second year at the University of Southern California School of Medicine. This summer as a lieutenant in the Army Medical Corps, he'll study receptor-mediated endocytosis at the Walter Reed Army Institute of Research in D.C. . . . **Burt Kaliski** is still a grad student at M.I.T. and will be on a short-term missionary project in Japan this summer with Campus Crusade for Christ. . . . **David Gonzales** is an army first lieutenant and a platoon leader with the 78th Engineer Battalion in West Germany. . . . **Mike Hughes** is a navy ensign and recently received his

"Wings of Gold" upon completion of the six-week Advanced Jet Navigation Course at the naval air station in Pensacola.

And on the wedding front: . . . **Michelle Heng** and **Randy Schweickart**, '83, are married and have a baby. . . . **Stacey and Dwayne Mann** are married. . . . **Mike Witt** is celebrating his first anniversary. . . . **Cliff Bartlett** was married at the beginning of the year. . . . **Beth Markey** recently married **Shawn O'Donnell**, '83. . . . **Steve Altes** married **Barbara**, and I hear they are working in Los Angeles for Rockwell. . . . **Eric Brandt** married **Darlene** and they are living in Wichita. . . . **Ed Seidewitz** married a gal named **Deborah** and works at NASA Goddard Space Flight Center as an aerospace engineer and computer scientist.

. . . **Scott Douglass** married **Margaret Hirlinger**, '85. She is finishing her first year of grad school toward a Ph.D. in physics at Stanford, and he works for Apple Computer in Cupertino. . . .

John Hammond and **Paula Goodwin** were wed in August '85 in Detroit, and are working for Motorola, Inc. in Ft. Lauderdale. Attending the wedding were: **Sabrina Lewis**, **Wanda Taliaferro**, '83, **Mike Durham**, **David McMullen**, '83, and **Kevin Johnson**, '83. . . . **Julia Goddard** married **Gerard Weatherby**, '83, and is living in Groton, Conn., working in the field of heating, ventilation and air conditioning. . . . **Laura Bagnall** is marrying **David Plummer**, '82, in October. She's working in Cambridge.

That's all for now. I've drained all of my sources! If anyone is in the Los Angeles area, drop me a line or give me a call. The M.I.T. National Alumni Conference is in Los Angeles this year, so I'll be attending in anticipation of our 5th reunion in 1989. Send all your gossip to either **Mona** or myself!—**Diane Peterson**, President, 350 Palos Verdes Blvd., Apt. 20, Redondo Beach, CA, 90277-6329, (213) 375-4991

85

Hello again! First, I must apologize if I haven't responded to anyone's letter. Since I've returned to California, my mail has been accidentally forwarded somewhere else. Well, if you think I don't know what you're up to—if you're in the service I receive nifty news all about you! **John Marti**, a second lieutenant in the marines corps completed basic school last January. . . . Navy commander **Michael Bosworth** reported for duty aboard the aircraft carrier *U.S.S. Ranger*, homeported in San Diego. Second Lieutenant **Mark Chase** is an honor graduate of the air force aircraft maintenance officer course. . . . And, **Robert Robinson** is the antisubmarine warfare officer on a destroyer out of San Diego. . . . congratulations to all!

I would like to inform you about **Ramanujam Manikalingam** (physics) from Sri Lanka. The most recent info I have regarding him (March) is that he was to have a hearing to determine whether there was enough evidence to indict him, in which case there will be a trial. I'm sorry, that's the total of my knowledge regarding Ramanujam. . . . our prayers are with him.

Kip D. Kuntz is working as a visiting research assistant at Canada-France-Hawaii Telescope Corp. in Kamuela for the summer. He says that it rains more than half of the day and that the cows outnumber the people. . . . Back at M.I.T., **James Hayten**, '75, and **Gail Nonnemacher** were married in the chapel last March. Gail is working for Dow Chemical in Georgia as a production engineer. She and Jim recently bought a house in Acworth—halfway between where each of them works.

Barry McQuain is working "as a research assistant for a government-sponsored study group which works directly for the secretary of the interior. It's kind of like *Jacque Cousteau* on land. . . . doing all types of collecting, analyzing, organizing, etc., many aspects of the national forests in the West Coast area." Barry and the others in his group have named their pick-up truck the

"Calypso." Previously, Barry was in North Dakota documenting migratory patterns of the bluestripped tern and in California and Oregon tracking moose. In June he was collecting sand in the Mojave Desert analyzing its contents. Now he should be back at Sloan to get an M.B.A. in finance. He wants to encourage his friends at Lambda Chi Alpha to write in. . . . I'd like to extend that to everyone!—**Stephanie Scheidler**, Secretary, 3511 Shafer Dr., Santa Clara, CA 95051, (408) 985-6651

86

Hi boys and girls! I'm still waiting for all those letters to start accumulating in my mailbox. It's a good thing I'm not holding my breath. Actually, I know it's not your fault, because I forgot to mention one small fact in my last column—there's a lag time of about four months between the time this column is written and the time it's published, that is, I wrote this column back in the beginning of July. So, keep this in mind while you peruse your way through the happenings of your classmates.

As I mentioned, I've received no written accounts from ya'll, so once again, I'll have to resort to hearsay. **Vivienne Lee**, our illustrious president, is in Cincinnati working for Proctor and Gamble. . . . **Suzanne Dunbar** and **Ray Brunsberg** are both down in the heart of Texas, Houston to be exact. They're employed by Solvay America. . . . **Heather Irving** has been doing research at the Boston University Medical School over the summer, and **Mary Bayalis** is headed out to Berkeley. She'll be doing graduate work there in the area of transportation. (It's funny—I heard most of this the night of the Senior Week Harbor Cruise—if you didn't make it, you missed a great time!)

I hope **Fred Johnsson** had fun painting houses in Vermont this summer, and **Andy Solem** should be taking Japan by storm about now. He is headed over there for graduate school before he goes into active duty for, guess who, the U.S. Air Force. . . . Also, I'm sorry **Henry (Henry Hoeh)**, ladies and gentlemen! I know you've told me a dozen times what you're going to be doing, but I just can't remember. (So drop me a line and let me know one more time. That goes for the rest of you.)

I made a small error last issue when I offered congratulations to all our newly-married classmates. I totally forgot about those who took the big step while we were still in school. So, with a huge apology, congratulations to **Tom Paterson** and his wife, **Mirta**; **John Unverforth** and his wife, **Karin Getschow** and her husband; and **Ensign Stephanie Curran** and her husband.

Carolyn Beer toured Europe this summer (I got a postcard from Regensburg, Germany) and I suppose by now she's settled in at the University of Illinois. She's working for a graduate degree in architecture. . . . Also, I found out second lieutenants **Greg Harrison** and **Sonya Sakai** will be joining me out in Los Angeles at Space Division. We'll have to get together and go bar hopping sometime. . . . To wrap up the military contingency, I hope the following second lieutenants enjoyed the basic school at Quantico Marine Corps Base this summer: **Eriberto Lozada**, **Doug Miller** and **Bill Vincent**.

Oh yeah, what have I been up to? Well, **Karen Wohl**, **Anne Fricker**, **Ellen Epstein**, and I drove down to Atlanta for the Amnesty concert held there in mid June. We crashed at **TJ Cradic's**, '88, house and guess what? The Police got back together just for Ellen. We then toured Duke University and Virginia Beach and finally ended up in Georgetown in Washington, D.C. We picked up **Stephen Genn** and partied late into the night with **Eric Andrews**, '87. That my friends, has been about it, as of June 26. Hope everyone's having fun. If I've forgotten anyone, write and let me know.—**Mary E. Cox**, Secretary, 14317 N. Brook Dr., Dale City, VA 22193

**Nauta attributes
his success as a teacher to being
"acutely aware of where the
anguish arises."**

into an entirely different mode of thinking. Instead of the daydreaming mode, you have to become a person of action. This entails that you get yourself—while thinking out loud, or even cursing out loud—to a telephone booth. And while marching there, you have to think of a person at the lab upon whom you can inflict yourself for the favor of getting the slides to you."

Intense Thinking Saps Endurance

Looking back on the incident, Nauta became aware of the exertion involved in shifting from a state of relaxation to one of active thinking. "It occurred to me that there's a strict resemblance to movement," he said. "To maintain a line of thought is something like an act of endurance. You need some motivational force to keep you going, as when jogging. By the time you're done, you're tired—15 minutes and all you've done is walk to a telephone!"

For the past few years, Nauta has been exploring the parallels between thought and movement. "For both you need something to start it off, and something to keep it moving. Thoughts frequently spill over into movement: a person's face changes when he's thinking, or he may express himself through body language, by pacing the floor, thinking out loud, or a rigid posture."

Nauta believed his ideas were original—"I thought I was the only one going totally off his rocker"—until he came across the century-old writings of Hughlings Jackson. "It's wonderful to know that if you talk nonsense, you talk nonsense in good company," Nauta said.

Jackson, a prominent British neurologist, was noted for his studies of epilepsy, a neurological disorder that affects both the thought process and motor control. In his own investigations, Nauta has found that thought and motion are not only closely related, they may share a common structure—the basal ganglia.

Even after his official retirement, Nauta plans to pursue this line of in-

vestigation at the McLean Hospital, where he has conducted research since 1975. "When you speak of thought, most people think of the cerebral cortex," he said. "I was hoping that if I sound off hard enough and keep yapping to my colleagues, they will look not only at the cortex, but also at the basal ganglia and the limbic system."

Future inquiry on the connections between thought and motion may shed light on various disorders and pave the way for improved treatment. Nauta points out, for example, that Parkinson's disease, a disorder of motion, and schizophrenia, a psychiatric disorder, have a common denominator. "In Parkinson's, there is a dearth of the neurotransmitter dopamine; in schizophrenia, an over-activity of the dopamine system," he said. "It's tempting to think that the two disorders are related."

Although his investigations will continue, Nauta's days as a classroom teacher have come to an end. "I shall miss it indeed," he said. "It's always been an exertion, but now that I'm 70, I find it extremely tiring. That's the price you pay for living so long."

A Subject "Dreaded and Loathed"

Nauta has trained generations of neuroscientists, and his instruction will be sorely missed. Neuroanatomy has traditionally been a required subject "dreaded and loathed" by medical students, according to M.I.T. research associate Steven Wertheim, '79. "Nauta made it understandable by telling amusing little stories."

"He makes it seem like you're not really studying," said one graduate student, who recently attended Nauta's elementary neuroscience class. "He makes it seem like he's describing something for the first time. Even if he's seen it a million times, he gets excited all over again."

Nauta attributes his success as a teacher to having done it for more than 40 years and "being rather acutely aware of where the anguish arises."

Edward Koh of Tufts believes there's

more to it than that. "There's a childlike curiosity about him that's really special," Koh said. He noted that "some people study neurosciences for the glory it can give them. Nauta does it out of genuine interest and respect for the brain. In class, he encouraged us to think of brain structures as 'old friends.' He not only demystifies the subject, he makes you care about it."

Wertheim agrees that Nauta is not ambitious in the traditional sense. "He grew up in a different era, before the 'publish or perish' ethic took hold. He takes the time to investigate things deeply. When he publishes, he has something to say."

Nauta routinely turns down offers to attend conferences, give talks, and sit on panels, in order to have more time for his own research. "It's highly unusual," Wertheim said. "Up until about a year ago, before work on his book became too pressing, he was active in the lab, conducting experiments on rats and analyzing data. Many senior scientists, even those in their 40s, don't walk into the lab at all. They get graduate students and post-docs to do their benchwork. They stop being scientists and become managers, administrators of science. Nauta avoided that, which was remarkable."

"He's less affected by his fame than anyone of his stature I've seen. People around here can be so inflated, so pompous. But he's never that way. He treats everyone the same, from a top scientist to the guy who empties out the garbage can. And he treats them with respect."

Reflecting on Nauta's numerous contributions, Koh has often wondered why he didn't win the Nobel Prize. "I'm still not sure, but I think it's partly because he didn't make one simple finding about the brain that blew people away. The impact Nauta had on neurosciences was comparable to what Watson and Crick did for genetics. But his work wasn't sexy. It wasn't a big splash."

"There's something funny about that. Here you have a great man whose main contribution is opening up the field so that 'any fool can do it.' □

I CIVIL ENGINEERING

An interesting new challenge for **John Fayi Elliott**, Ph.D.'69: as of last January, he is officer-in-charge of the Industrial Operations Section of the United Nations Economic Commission for Africa (ECA) and Industrial Development Organization (UNIDO). He describes his job as "managing the delivery of assistance to 50 member states of ECA for local development of chemical, metallurgical, and agro- and forest-based industries." The emphasis is on "ensuring self-reliant and self-sustaining economic development," he says.

Stationed in Addis Ababa, Elliott is chairman of the local chapter of the Society for International Development; he's teaching a course in electronic data processing and computer programming, is secretary of the UN Staff Savings and Credit Cooperative, and has an array of committee assignments for the UN.

John P. Dugan, Jr., S.M.'68, a vice-president of Haley and Aldrich, Inc., is now manager of the firm's new branch office in Glastonbury, Conn.

... A promotion for **Harold J. Parmelee**, '60: formerly vice-president of Turner Construction Co. and general manager of its New York operations, Parmelee is now executive vice-president responsible for all operations in the Eastern Division.

... **Leonard Stolba**, S.M.'63, who works in Sacramento as manager of projects in the west for Parsons Brinkerhoff, is now vice-president of Parsons Brinkerhoff Construction Services, Inc.

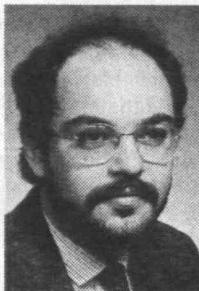
The Wall Street Journal reports the promotion of **Cordell W. Hull**, S.M.'57, executive vice-president of Bechtel Power Corp., to hold the same title with the parent Bechtel Group, Inc., in San Francisco. ... **James A. Champy**, S.M.'63, is now vice-chairman of Index Systems, Inc., Cambridge; he was formerly vice-president and general counsel.

II MECHANICAL ENGINEERING

John H. Sununu, '61, the department's number-one alumnus in public life, has filed for a third term as governor of New Hampshire and is campaigning on his record of bringing efficiency and economy to the state government. His support of the beleaguered Seabrook nuclear plant is the opponents' chief issue, but Sununu insists that "we have a greater demand for electricity at peak than we have the ability to deliver."

In "A Short History of Human-Powered Vehicles" in *American Scientist* for July-August, Professor **David Gordon Wilson** of M.I.T. writes that new materials and designs—and stronger athletes—are combining "to break, by astonishing margins, records on land, on water, and in the air." But on the question of whether that progress can continue in the future, Wilson is silent.

A new honor for Professor **Nam P. Suh**, '59, who's at the National Science Foundation on leave from M.I.T.: the honorary degree of doctor of engineering from Worcester Polytechnic Institute.



I. Vasatis



C. P. Weigel



M. Scholer



B. J. Wolff

III MATERIALS SCIENCE AND ENGINEERING

David A. Higbee, S.M.'65, has a new assignment: president of National Supply Co., Houston, an Armc division. He continues to serve as general manager—National Production Equipment. ... The Center for Technology and Policy at Boston University received a \$100,000 grant from the Bell and Howell Co. in memory of the Center's late founder and director **J. Herbert Holloman**, Sc.D.'40. The grant will fund three post-doctoral fellowships to continue the work of Holloman in the areas of industrial innovation, industrial research and productivity, and technology and work.

Ioannis P. Vasatis, Ph.D.'86, is a metallurgist with the General Electric Research and Development Center, Schenectady, N.Y. ... **C. Philip Weigel**, S.M.'69, is now president of Latrobe Steel Co., a division of the Timken Co. He succeeds **Marshall Scholer**, (S.B. '45, Course I), who retired. Weigel joined Timken in 1955, and he had had increasing responsibilities in the company's steel operations, most recently as executive vice-president of Latrobe Steel Co. ...

Joseph I. Goldstein, Sc.D.'64, vice-president for research and professor of materials science and engineering at Lehigh University, is co-author of *Advancing Scanning Electron Microscopy and X-Ray Microanalysis* (Plenum Press 1986).

Two distinguished members of the department faculty at M.I.T. reached retirement at the end of the last academic year: **Robert L. Coble**, Sc.D.'55, and **Nicholas J. Grant**, Sc.D.'44; their combined service totals over 65 years. Upon completing his doctorate, Coble worked for five years at the General Electric Research Laboratory and then returned to Cambridge to become assistant professor of ceramics, reaching the rank of full professor in 1969. He's widely known for contributions to ceramic technology and as a teacher of ceramics and materials processing, a fellow of the American Ceramic Society and former officer of its Basic Science Division, and winner of ACS's Sosman Lectureship, the highest recognition for basic research in understanding the properties of ceramics. Grant has taught at the Institute since 1944, when he became an instructor in the department, and he's among its best-known faculty in steelmaking and high-temperature materials.

Grant is the author of over 300 technical papers, book chapters, and review articles; he holds 30 U.S. and over 100 foreign patents; and he's been widely honored for contributions that have had major impacts on the metals industry—including most recently his work on rapid solidification.

Paul A. Tichauer, Ph.D.'71, has been appointed president and chief executive officer of Teledyne McKay, York, Penn. Tichauer formerly served as general marketing manager for Linde Division of Union Carbide in Canada.

Louis Tibor Kiss, S.M.'69, a distinguished industrial scientist in coal science and X-ray and electron beam analytical systems, passed away on April 16, 1984, in Mt. Waverly, Australia. At the time of his death, Kiss was head of the Coal Science Research Division of the State Electricity Commission of Victoria, Australia. Among Kiss's other accomplishments: he served as a plenary lecturer at a analytical meeting run by the Victoria Branch of Royal Australian Combustion Institute (1966), out of which developed the RACI Analytical Chemistry Department.

IV ARCHITECTURE

Josephine O. Adams, M.Arch.'80, is regional project engineer with United Parcel Service, New York City. ... **Craig D. Roney**, M.Arch.'71, is associate architect with Kobler/Belluschi, Architects, Chicago. ... **Muhammad Abdu-Sabur**, M.Arch.'77, has accepted a position as senior project manager with the Boston Redevelopment Authority. ... **Bernard Rothzeid**, M.Arch.'54, has been honored with the 1986 Augustus Saint-Gaudens Award of the Alumni Association of the Cooper Union for the Advancement of Science and Art. Rothzeid is a principal of Rothzeid, Kaiserman, Thomson, and Bee, P.C., Architects and Planners, New York City.

Three alumni have been advanced to the American Institute of Architects College of Fellows (1986): **Barry Benepe**, B.Arch.'55, of New York City; **Mason S. Hicks**, M.Arch.'50, of Fayetteville, N.C.; and **Ki Suh Park**, M.Arch.'59, of Gruen Associates, Los Angeles, Calif. ... As a principal in O'Brien/Atkins Associates, Durham/Chapel Hill, N.C., **Philip G. Freelon**, M.Arch.'74, is serving as project engineer for the new 30,000 square-foot American Airlines hub under construction at the

Raleigh-Durham Airport. In addition to his architectural work, Freelon is teaching professional practice courses in the School of North Carolina State.

Bernard J. Wulff, M.Arch.'64, has been named principal in charge of the Washington office of RTKL Associates, describes as one of the country's largest and fastest-growing architectural and engineering firms.

V CHEMISTRY

Frank Vellaccio, Ph.D.'74, has been appointed academic dean of Holy Cross College, Worcester, Mass. As academic dean, his primary goal, he says, is to strengthen the college by improving the caliber of faculty members and resources—"the key to keeping quality for the students," said Vellaccio. . . . **Leonard M. Baker**, Ph.D.'60, has been promoted from director of corporate technology to vice-president for technology of the Specialties and Services Business Group at Union Carbide Corp., Danbury, Conn. . . . **John M. Deutch**, Ph.D.'61, provost at M.I.T. who was President Jimmy Carter's Undersecretary of Energy, was awarded an honorary Doctor of Humane Letters during the University of Lowell's June 1986 Commencement Exercises. . . . **Elias J. Corey**, Ph.D.'51, professor of chemistry at Harvard University (since 1959), was cowinner of Israel's 29th Wolf Foundation Prize for Chemistry with a \$100,000 honorarium. The Wolf Prize Committee cited Corey's achievements as revolutionizing "our knowledge of the molecular basis of inflammation, immunology, and other areas of medicine."

Retirement came at the end of 1985-86 academic year to Professor C. Gardner Swain, whose association with M.I.T. began in 1946. He is a recognized specialist in physical organic chemistry and the mechanisms of reactions. Swain's course in the subject, given for 24 years at M.I.T., was noteworthy for its emphasis on quantitative relationships and its inclusion as early as the 1960s of three weeks of computer programming applied to evaluating catalytic rate constants and molecular properties. Swain was honored on the eve of his retirement by a symposium of the Division of Organic Chemistry at the New York meeting of the American Chemical Society last April and by a recognition banquet at the Chemists Club on April 14.

George A. Frank, Ph.D.'65, reports that last January 1 he was promoted to senior counsel in the Legal Department of E.I. du Pont de Nemours and Co. . . . **Robert Nelson**, Ph.D.'69, writes, "I am currently associate professor of chemistry at Georgia Southern College, Statesboro. I will be spending the summer of 1986 and winter of 1987 at NASA/Goddard Space Flight Center (Greenbelt, Md.), working on interstellar dust properties. I'd love to hear from fellow Tech graduates while in the Washington, D.C. area—(301)344-6364." . . . **Helen F. Tucker**, Ph.D.'33, of Sarasota, Fla., passed away on February 25, 1986; no further details are available.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

After 13 years in the Dugald Caleb Jackson Chair at M.I.T. and more than 30 years on the Institute faculty, **Louis D. Smullin**, S.M.'39, has retired from full-time teaching. Smullin came to the Institute in 1941 to join the World-War-II Radiation Laboratory, and he's been here almost continuously since then—organizing and heading a microwave tube laboratory in the Research Laboratory of Electronics (1950), heading the Radar and Weapons Division at Lincoln Laboratory (1952), and finally joining the faculty (1955) to teach plasma dynamics and head RLE's Active Plasma Systems Group. Smullin is widely recognized for work in microwave electronics; it was he and his students who in 1962 first bounced a

Brain Scientist and Ocean Engineer, In Tandem

Ted Milner, a post-doctoral fellow in Professor Emilio Bizzi's lab in the Whitaker College of Health Sciences, Technology, and Management, is a specialist in movement. In his role as a neurophysiologist, he studies motor control. Motor control is also his specialty when he straddles his tandem bicycle, but on these occasions, he is the motor—or at least half of it.

In late September, Milner and his partner, Hauke Kite-Powell, '84, whose MIT's degrees are in Course XIII, expected to make a second attempt to break the world distance record for tandem bicycle during a 24-hour period.

Milner has a lot of tandem experience. His first partner was his brother, with whom he pedaled 3,800-plus miles across Canada in a little under 16 days. Their record, established in 1981, still stands.

Milner and Kite-Powell's first try at setting the world record for 24 hours of continuous riding, made in June, was plagued by bad luck. The promised loan of a special aerodynamic rear wheel didn't come through on time from the California manufacturer; it started to rain just as they began their tour; and they failed to make allowances for a metal grid bridge that became slippery when it rained.

The record for the day-long tandem ride, as recognized by the Ultra Marathon Cycling Association, is 432 miles. Milner and Kite-Powell were looking to do at least 550 miles in their second attempt.

To meet their goal of speed and endurance, both men trained strenuously—pedaling about 500 miles a week. Most of this was done independently on single bicycles. When they were both in Cambridge, they also trained together on the tandem, usually over the weekend, when they sometimes covered as many as 250 miles.

For the 36-year-old Milner, this meant that during the week he was out of bed by 5:30 in the morning. He then rode for approximately five hours (or about



100 miles) and arrived at the lab in the early afternoon. Since he often works alone on his research projects, he can usually work during the hours he chooses.

Kite-Powell, 23, spent the summer in Germany—with his bicycle—on a "training vacation" before he embarks on a second master's degree, this time in M.I.T.'s Technology and Policy Program.

Kite-Powell finished his S.M. in ocean systems management in January. At that time he was a teaching assistant for Henry Marcus of the Department of Ocean Engineering, and his thesis focused on defining "high technology" in terms of marine industries—what it means and the implications for government and industrial policy.

According to a friend, Linda Bowman, Kite-Powell took three months off last spring to train for the tandem rides and for an attempt to break the world record of 146 hours for a ride from Miami, Fla. to Portland, Me. Unfortunately, he was unable to garner adequate financial support for the latter venture.

Milner is a native of Canada, who now does research on the ways the brain, muscles, and nerves relate to produce movement. He received bachelor's, master's, and Ph.D. degrees from the University of Alberta at Edmonton. In addition to racing in a number of competitions, such as the National Cycling Championships in Canada, Milner was



Top: in training to break the long-distance record for a tandem bike marathon, Ted Milner and Hauke Kite-Powell cover up to 500 miles per week, on the tandem if possible, wearing aerodynamically-designed helmets. **Above, from left:** Milner and Kite-Powell.

an organizer for the cycling division of the World University Games.

When asked if he'd ever thought of trying out for the Olympic bicycling team, Milner said that "You have to begin at about 16 for that." Milner began cycling when he was 21.—Laurie Ziesk □

LAURIE ZIESK is a freelance writer.

laser beam off the surface of the moon. Smullin was head of the department from 1966 to 1973, a period of rapid growth in its offerings in computer science. Most recently he has been involved with several colleagues in conceiving a "continuing education" program in EECS for M.I.T. Technion-Israel Institute of Technology celebrated Smullin's retirement by giving him an honorary Sc.D. degree in June.

Stephen J. Jatras, S.M.'52, has retired as president but retains the titles of chairman and chief executive officer of the Telex Corp., Tulsa, Okla.

... Brian Hinman, S.M.'84, and Jeff Bernstein, S.M.'84, founders of PicTel, Peabody, Mass., have recently announced that their firm has developed "a picture telephone" which can transmit color images over regular phone lines. The equipment is scheduled to be sold for \$70,000 per installation beginning this fall. The reward for this invention was company stock worth \$21.3 million, a sum made possible by the inventors meeting an underwriter's deadline in PicTel's 1984 initial public stock offering. ... Richard W.

Holm, S.M.'86, an air force second lieutenant and an electro-optics engineer has begun service with the Air Force Weapons Laboratory, Kirkland Air Force Base, N. Mex.

Benjamin L. Leon, Sc.D.'59, has been named director of Southern Methodist University's Telecommunications Program in the School of Engineering and Applied Sciences. Leon moved to Dallas last summer from his post as professor of electrical engineering at the University of Kentucky, Lexington. ... George

Zames, Sc.D.'60, has won the 1985 IEEE Field Award for Control Science and Engineering, and he holds senior fellowships of the Killam Foundation and the Canadian Institute for Advanced Research. Zames is currently Macdonald Professor of Electrical Engineering at McGill University, Montreal. ... Samuel C. (Sandy) Goldman, S.M.'55, writes: "At the start of 1986, I established T-MAC, the Technical Management Advisors Corp., Sharon, Mass. Our management services include medical practice operations, company and product evaluations for prospective investors, five short courses relating to excellence in technical operations, and promotional work for professional practices. I've been delighted with the business growth—I guess T-MAC is filling a need in assisting professionals in the marketing of their services in today's competitive climate. Mary-Glenn (wife) has been appointed assistant director of corporate development at the Boston Symphony Orchestra. ... I'd love to hear from '55ers ... who are concerned with the methods, media, and ethics of selling their services. I'm always looking for new ideas."

Mark Horowitz, S.M.'78, assistant professor of electrical engineering who is team leader at Stanford's University's Center for Integrated Systems, has developed a microprocessor chip capable of hitting speeds of 20 million instructions a second and running in parallel with others like it. ...

Alan J. Roberts, S.M.'51, has been promoted to senior vice-president of MITRE Corp.'s Washington C.I. Division. Roberts was formerly a vice-president, and with his new title will continue as general manager of the division. ... Barry K.

Levitt, Ph.D.'71, writes that he recently was co-author of a three-volume text, *Spread Spectrum Communications*, published by Science Press, Rockville, Md.

Jose B. Cruz, Jr., S.M.'56, was recently designated as professor and chairman of the Department of Electrical Engineering at the University of California, Irvine. ... Peter B. Miller, S.M.'75, is director of Advanced Development at the Lotus Development Corp., Cambridge. ... As a member of the M.I.T. Graduate Student Council's Housing and Community Affairs Committee, Carey Rappaport, E.E.'82, is a strong advocate of graduate student housing. In a letter to *The Tech*, he urges that "the key point now is: keep up the pressure! Show the administration that housing is a big deal that matters to all graduate students."

Three were honored last June 30 at M.I.T.'s annual retirement dinner: John Ruze, Sc.D.'52, for 23 years of service at Lincoln Laboratory's Division 3; Arthur Linz, '46, for his 26 years of service in the Electrical Engineering and Computer Science Department; and Carl Blake, S.M.'49, for his 29 years of service at Lincoln Laboratory's Group 33. ... Kenneth H. Olsen, S.M.'50, president of Digital Equipment Corp., has received two recognitions: the first Computer Entrepreneur Award by the IEEE Computer Society for "having pioneered the development of small computers and for his foresight in the founding of Digital . . ." and a Medal for Entrepreneurial Excellence from the Yale School of Management. ... Lance A. Glasser, assistant professor in the department at M.I.T. won the 1985-86 Frederick Emmons Terman Award presented by the Electrical Engineering Division of the American Society for Engineering Education. Glasser was recognized for "his insight into design strategies for electronics, especially in the area of VLSI circuits . . ." ... Russell C. Buehl, Sc.D.'37, of Sarasota, Fla., passed away on June 1, 1986; no further details are available.

VI-A Internship Program

Technology (Alumni) Day activities I attended included the breakfast in the Sala de Puerto Rico and the annual Alumni Association luncheon in the new Athletic Center. I did not encounter as many VI-A alumni as in previous years, however. Those I met: Arthur V. Chen, '61, Irwin Dorros, '56, Peter R. Gray, '61, Robert L. Lagace, '60, Donald E. Nelsen, '61, William E. Northfield, '56, and Mitchell P. Tasman, '82.

I also had the privilege for the first time of attending the traditional wine and cheese gathering before lunch, hosted by *Technology Review*'s editor-in-chief John Mattioli, for class secretaries who write for the *Review*. I was introduced to a Carole A. Clarke, '21, who said he was from Course VI, but many of his friends were in Course VI-A and they made him, I thought he said, "honorary member of VI-A," but he corrected me to emphasize he had said "ornery member" because of his not joining VI-A with his friends. I told him we could start a club of "ornery members" from people who've told me over the years they wished, afterwards, they had joined VI-A.

This year another member of the EECS Department was elected to honorary membership in the M.I.T. Alumni Association; Professor Mildred S. Dresselhaus. You may recall this honor was bestowed to John Tucker last year.

In the booklet "A Memorial Service for M.I.T. Alumni" (service held in the Chapel on Technology Day), I noted the death of Jonathan T. Freuh, '76, on March 7, 1986. I do not know any other details. Other deceased VI-A's, reported on previously, included Winthrop F. Potter, '22, and Professor (Emeritus) Karl L. Wilkes, '22.—John A. Tucker, Director, VI-A Internship Program, M.I.T., Room 38-473, Cambridge, MA 02139

VIII PHYSICS

Franklin Chang-Diaz, Ph.D.'77, was one of 12 to receive a special Medal of Liberty at the centennial celebration of the Statue of Liberty (see *July, page MIT 32-33*). The 12 recipients had all emigrated to the United States. ... Robert J. Birgeneau, Cecil and Ida Green Professor of Physics at M.I.T., received a Wilbur Cross Medal for Outstanding Achievement in Professional Life awarded by Yale University at its 1986 Commencement Exercises. ... Elsa Garmire, Ph.D.'65, a research scientist in linear and nonlinear optical devices who is professor of electrical engineering and physics and director of the Center for Laser Studies at the University of Southern California, was a speaker during Radcliffe's Commencement-Reunion Week activities, last June 3-8. Garmire spoke on a panel devoted to creativity

in the arts and sciences. . . . **Paul D. Lazay**, Ph.D.'69, has been named vice-president of engineering at Telco Systems Fiber Optics Corp., Norwood, Mass., a subsidiary of Telco Systems, Inc. Lazay was formerly vice-president and director of engineering at ITT Corp.'s Electro-Optical Products Division, Roanoke, Va.

Max Weiss, Ph.D.'65, has been named corporate vice-president and manager of Northrop Corp.'s Research and Technology Center, Palos Verdes, Calif.; he was formerly engineering group vice-president at Aerospace Corp. . . . **Albert Wheelon**, Ph.D.'52, has been elected executive vice-president—operations for Hughes Aircraft Co., responsible for the operations of the company's six major organizations; he's a member of the Board of Directors and the company's Executive Committee. Wheelon was formerly president of the Space and Communications Group. . . . **George Hoagland Vineyard**, Ph.D.'43, physicist and former director of the Brookhaven National Laboratory, received the honorary doctor of science degree from the University of Missouri, Columbia, last May.

Five distinguished members of the department at M.I.T. retired at the end of the 1985-86 academic year: **Herald A. Enge**, **Robert I. Hulsizer, Jr.**, Ph.D.'48, **Benjamin Lax**, Ph.D.'49, **Philip Morrison**, and **Clifford G. Shull**. Enge has taught in Cambridge since 1955, when he came from his alma mater, the University of Bergen, Norway; he has published and taught in the field of nuclear spectroscopy. Hulsizer came to M.I.T. to direct the Science Teaching Center in 1964, a post for which wide experience in education gave him special qualifications. Since then, in addition to teaching, Hulsizer has worked in experimental high-energy physics; he and Mrs. Hulsizer were residents in Ashdown House until last year. Retirement from the faculty follows by five years Lax's retirement as director of the Francis Bitter National Magnet Laboratory, a post he held since the laboratory's founding in 1960; indeed, the laboratory was based in considerable measure on the high-magnetic-field research of Lax and his Lincoln Laboratory colleagues in the 1950s. Cosmologist Morrison has been one of the best-known and most popular members of the department, a respected scholar, effective interpreter of science to the public, and outspoken advocate of nuclear arms control. Neutron physics is Shull's specialty; in 1966, the year he came to the Institute from Oak Ridge National Laboratory, Shull was honored with the Buckley Prize of the American Physical Society, and he has continued studies since then of electron configurations in metallic elements and alloys.

Walter J. Fader, Ph.D.'55, a senior physicist at United Technologies Research Center, East Hartford, Conn., passed away on June 19, 1986. Fader's work was in the fields of laser systems, plasma physics, and fusion. He had joined Pratt and Whitney Aircraft as a physicist in 1955 and served with the firm for more than 31 years—including a two-year assignment at the Oak Ridge National Laboratory experimenting with the aircraft nuclear propulsion program. . . . **Rockwell Kent III**, Sc.D.'48, owner of Kent Laboratories, Upton, Mass., passed away on April 8, 1986. Kent was a specialist in spectroscopy, a past president of the Society of Applied Spectroscopy, and a member of the Grafton-Upton Unitarian Universalist Church. . . . **Robert W. French, Jr.**, S.M.'35, a scientist in optical engineering for the Itek Corp., Lexington, Mass., prior to his retirement, passed away on June 9, 1986. French was a member of the Optical Society.

X CHEMICAL ENGINEERING

Curt B. Beck, S.M.'52, has been named a fellow of the American Institute of Chemical Engineers. Beck is editor and publisher of the *Four-State Environment/Energy Newsletter* and was formerly energy and environmental specialist for the Cabot Corp., Pampa, Tex. Beck was cited for his work

in developing "new, environmentally sound processes for the manufacture of carbon black, as well as for his record of service to the AIChE."

. . . **George R. Berbeco**, S.M.'66, continues as president of Charleswater Products, Inc., West Newton, Mass., following its acquisition by Armstrong World Industries, Inc. Charleswater Products is a maker of a complete line of static control products.

Rena Bizios, Ph.D.'79, was promoted to associate professor with tenure in the Department of Biomedical Engineering at Rensselaer Polytechnic Institute, Troy, N.Y. Bizios's area of interest is in applying the principles of biomedical engineering to thrombosis. . . . **Robert B. Flanders**, S.M.'58, writes: "Retired as of January 1, 1986, and loving every minute! Do what I want to do, when I want to, and if I want to. Great not knowing what I'm going to do today. Many interests and projects for at least the next 25 years." . . . **Eva Ma Wan**, S.M.'81, is presently working for Drexel Burnham Lambert as an associate in the Fixed-Income Securities Department, New York City. . . . **Lyle C. Jenness**, '37, of Orono, Maine, passed away on May 4, 1986; no further details are available.

XI URBAN STUDIES AND PLANNING

William D. Toole, M.C.P.'54, is now administering a low-interest loan program for residents of the Brant Rock section of Marshfield, Mass., who want to rehabilitate their homes. The funds were provided late last year by a Massachusetts Small Cities Grant, a program that provides loans at 3 percent interest for upgrading houses to conform to building codes. When he started the job, Toole was fresh from a similar assignment for Provincetown, Mass.

Sheri M. Pruitt, M.C.P.'82, writes that she completed a Master's degree in architecture at Catholic University in 1985 and is now an intern architect at Collins and Kronstadt, Washington, D.C. . . . **James E. Wallace**, Ph.D.'72, completed two major projects in 1985: a study for Marshfield, Mass., on housing affordability and development controls; and a national estimate for HUD of lead paint hazards and abatement costs in public housing. . . . A shingle on the door of 110 North Royal St., Alexandria, Va., carries the name of the new landscape architecture firm of Rhodeside and Harwell, of which **Deana D. Rhodeside**, Ph.D.'78, is founding partner.

We report with regret the deaths of **William B.S. Leong**, M.C.P.'48, in Hookset, N.H., on March 17, 1986, and of **Seymour Stillman**, M.C.P.'48, in Flushing, N.Y., on December 22, 1985. Leong was planning officer for Haverhill, Mass., from 1958 to 1961 and for Lowell, Mass., from 1961 to 1966. He then served in Pakistan and Thailand as a consultant to AID and held planning posts for HUD in Boston and Manchester, N.H., before retiring in 1985. As a longtime consultant to Duke University, he was chief landscape architect for its Sarah P. Duke Gardens. . . . During a 37-year planning career, Stillman was associated with Buffalo, Atlantic City, New York City, and Long Island City; at the time of his death, Stillman was a resident of Flushing, N.Y.

XII EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

A big new job for **Charles T. Prewitt**, Ph.D.'62: formerly professor of earth science and materials science at the State University of New York at Stony Brook, he became—effective July 1—director of Geophysical Laboratory of the Carnegie Institution of Washington. Prewitt studied crystallography and mineralogy at M.I.T., and he taught in those fields at SUNY beginning in 1969; previously he had worked in structural chemistry as a research scientist at Du Pont. Before moving to Washington this summer, Prewitt presided as general chairman of the 14th annual meeting of the International Mineralogical Association at

Stanford; he's chairman of IMA's Commission on Physics and Minerals.

Back from a Peace Corps teaching assignment at the University of Nairobi, **Guy J. Consolmagno**, S.M.'75, is now on the faculty at Lafayette College. . . . And **Jane Silverstone**, Ph.D.'85, writes with obvious delight that she is now assistant professor of geology at Harvard. Meanwhile, **Susan E. Humphris**, Ph.D.'77, formerly its chief scientist, has become dean of the Sea Education Association in Woods Hole, Mass.

Professor **Gene Simmons** of M.I.T. is reported to have had a key role in the Department of Energy's decision to abandon a plan to store high-level radioactive wastes in New England. Simmons told a hearing in Augusta, Maine, last spring that the granite slab underlying much of the state from Portland to the White Mountains is thinner than most geologists believed, and the regional representative of DOE agreed that the new data was "pretty significant."

Bradford Butman, Ph.D.'75, and his wife **Cheryl Ann Butman**, Ph.D.'84, report from Woods Hole: Bradford is a physical oceanographer for the U.S. Geological Survey, Cheryl Ann is assistant scientist in the Ocean Engineering Department, Woods Hole Oceanographic Institution. . . . Meteorologist **Stephen J. Sycuro**, S.M.'85 (Capt., USAF), has been decorated with the Air Force Achievement Medal at Hanscom Air Force Base, Mass. . . . **Ted Bettinen**, S.M.'68, who studied geophysics at the Institute, has switched to finance: he's completed Kidder, Peabody and Co.'s investment executive training program and he's now an investment executive in the company's Providence office.

Athelstan F. Spilhaus, Jr., Ph.D.'65, has been executive director of the American Geophysical Union for 16 years, a period in which its membership has nearly doubled and its activities expanded many-fold. Now a new chapter is beginning, with the association of AGU as a member society of the American Institute of Physics. It is AIP's second-largest member society (after the American Physical Society), and Spilhaus says the new affiliation will give both groups added leverage on public policy issues.



C. Calvano

XIII OCEAN ENGINEERING

Charles Calvano, N.E.'70, has left his position of officer in charge at the David Taylor Naval Ship Research and Development Center, Annapolis Laboratory, Md., to become commanding officer of the Navy Engineering Duty Officer School, Vallejo, Calif. . . . **Geoffrey L. Abbott**, S.M.'82, reports his latest activities: passed the examination and registered as a professional engineer in Virginia; in his post as Coast Guard program manager for solar power conversion of lighted aids to navigation supervised the conversion of 4,500 buoys, lighthouses, etc.; and took a new assignment (September 1986) as chief, Ocean Engineering Section, Ninth Coast Guard District, Cleveland, Ohio. . . . **John Piotti**, S.M.'85, has been named the first full-time administrator for the Community Advisory Board of the Massachusetts Water Resources Authority, and a new public authority charged with the clean-up of Boston Harbor.

Michael R. Donovan, S.M.'75, is working as a program manager for government projects at Solar Turbines, Inc., San Diego. . . . **A. Dennis Long**, S.M.'75, writes, "I was married on August 24, 1984, and currently work as senior scientist and public health engineer in the Environmental Risk Management Department for Bechtel National, Inc., San Francisco. In 1983-84, I was the AAAS Science Engineering and Diplomacy Fellow at the U.S. Agency for International Development. I completed my Sc.D. in tropical public health at Harvard in 1981." . . . **Lawrence K. Donovan**, S.M.'71, is a project manager with Bechtel National, Inc., San Francisco. Donovan retired from the Navy after 27 years of service in October 1985, and he and his wife Judi and children live in Walnut Creek, Calif.

Mason Dix Harris, S.M.'23, a retired engineer in the Pipeline Planning Department at Standard Oil Co. of Ohio, passed away in March 1986. Following Harris's retirement in 1939, he served as assistant to the director of the Fitchburg (Mass.) Art Museum for several years. Harris served with the U.S. Navy for 10 years, involved in the reduction of the World War I Naval Fleet, retiring as commander. . . . **Francis B. Merkle**, S.M.'41, a retired navy captain who served as a senior staff engineer with Wheeler Industries, Washington, D.C., passed away on March 8, 1986. During World War II Merkle served as an engineering officer aboard the carriers *Yorktown* and *Essex*. His most recent assignment before retirement from active naval duty in 1959 was as commander of the U.S. Naval Boiler and Turbine Laboratory, Philadelphia.

Richard Watt, Jr., S.M.'23, a retired rear admiral in the U.S. Navy, passed away in December 1985. Watt's expertise was in the design and construction of surface ships, and he also designed and tested some of the early diving bells for submarine rescue. Watt received the Legion of Merit

from the Secretary of the Navy during World War II and also a special commendation for his contribution to the production of destroyers and landing craft. Following retirement, Watt served as a consultant for Kaiser Corp. and Grumman Aircraft Corp. . . . **Peter Bergen**, N.E.'66, of Ottawa, Canada, passed away on June 17, 1983; he was associated with the Canada Department of Industry, Trade, and Commerce at the time of his death.

XIV ECONOMICS

A major event at M.I.T. last spring was the retirement of three members of the department whose names are "household words" at the Institute: Professors **Robert L. Bishop**, **E. Cary Brown**; and **Paul A. Samuelson**. Together they represent an astonishing 125 years of teaching experience at M.I.T. Bishop joined M.I.T. while a Harvard graduate student in 1946. He became professor in 1957, was head of the department from 1958 to 1964, and went on to be dean of the School of Humanities and Social Science from 1964 to 1973. Like Bishop, Brown began teaching at M.I.T. before finishing the Harvard degree, and he went on to succeed Bishop as head of the department—a role he fulfilled from 1965 to 1983. For two years thereafter Brown was associate dean of the School of Humanities and Social Science. Samuelson joined M.I.T. in 1940, a year before finishing his Harvard degree, rose to the rank of associate professor in 1944 and full professor in 1947. Notable among his countless honors is his election as Institute Professor in 1966.

Catherine L. Mann, Ph.D.'84, reports, "I am an economist at the Federal Reserve Board, Washington, D.C., doing research on trade policy and international financial innovation. Believe it or not, I miss teaching those Course XIV undergrads!"

. . . **Michael R. Dohan**, Ph.D.'69, is associate professor of economics at Queens College, N.Y., where he is director of the Social Science Laboratory for Research and Teaching. It is a large microcomputing and mainframe facility for students and faculty in the social sciences. . . . **Regina Herzlinger**, '65, is the first woman to hold an endowed professorship (the Nancy R. McPherson Professorship of Business Administration) and the second to be appointed full professor at the Harvard Business School. Herzlinger's specialty is in accounting and financial control of non-profit institutions, and she's a well-known authority on the American health care industry.

James A. Daley, '50, has been elected vice-chairman of Connecticut National Bank, Hartford, the principal subsidiary of the Hartford National Corp. Daley joined the bank in 1968, specializing in the management of the bank's data-processing operations. . . . M.I.T. Institute Professor **Robert M. Solow** received the an honorary Doctor of Social Science degree from Yale University at its 1986 commencement exercises. . . . Another honorary doctorate to: **Lester C. Thurow**, Gordon Y Billard Professor of Economics and Management, an LHD from Aldephi University.



K. R. Hootnick

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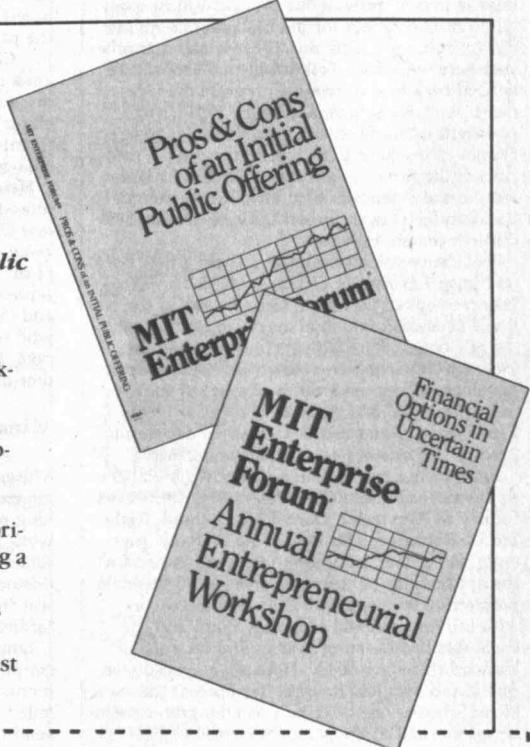
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XV MANAGEMENT

Robert H. Judd, S.M.'85, has been named director of marketing at the MetraByte Corp., Taunton, Mass., a manufacturer of data acquisition and control products. . . . **Mary N. Young**, S.M.'79, is president of Chrysler Capital Funding Corp., Greenwich, Conn., and regional sales manager for the commercial financial group of Chrysler Capital Corp. . . . **Krishna Challa**, Ph.D.'74, is division chief of planning and budgeting at the World Bank, Washington, D.C. . . . **Linda Kay Smith**, S.M.'79, has been appointed an industrial liaison officer at M.I.T. Smith is founder and former chairman of the Achievers, Inc., Boston, and was formerly manager of the Value-Added Relicenser Program at Lotus Development Corp.

William C. Hurd, S.M.'72, of Memphis, Tenn., reports that he is in the private practice of ophthalmology and has a patent pending on an intraocular biometric device. . . . **Bernard R. Horn, Jr.**, S.M.'80, writes, "Horn and Co., a full-service investment counselling firm specializing in global portfolio management, recently organized a multi-million-dollar pooled fund for domestic equity investments." . . . **Charles R.H. Tsiang**, S.M.'66, of Summit, N.J., writes that he is "currently in the Treasurer's Department of Exxon International, coordinating credit for crude sales by Exxon. Had a great time with two trips to Vail this winter to ski with my wife Sally and four-year-old son Matthew."

Judith A.F. Galman, S.M.'81, reports from Gaithersburg, Md., "My elder daughter, Nancy, just completed her first year at M.I.T. She is majoring in mechanical engineering. My nephew, Bruce, enrolled as a freshman this fall." . . . **G. Mark Pomeroy**, S.M.'82, writes, "I am taking a short break from program management at G.E. to involve myself more in our product's technology. I'll be chief engineer for the F110 aircraft engine (flown in the F14, F15, and F16) for about another year here in Kansas. Following this, I should be headed back East to resume program management." . . . **Richard A. Derbes**, S.M.'71, vice-president in the Research Department of Morgan Stanley, New York City, has been named a principal of the firm. . . . Professor **Phyllis A. Wallace**, in the Sloan School at M.I.T., received an honorary LHD from Brown University at its 1986 commencement exercises.

Two chapters came from M.I.T. for a new book on *National Policies for Developing High-Technology Industries* edited by Carole Ganz Brown of the National Science Foundation and Francis W. Rushing of Georgia State University (Westview Press, 1986, \$26.50). The two authors are **Amar Gupta**, postdoctoral associate, on the impact of computers in India, and Assistant Professor **Denis Fred Simon**, who describes Taiwan's decision to promote informatics as a "strategic industry."

Retirement came to four well-known members of the Sloan School faculty last spring: Professors **Sidney S. Alexander**, **Daniel M. Holland**, **Richard D. Robinson**, and **Phyllis A. Wallace**. Alexander is the theorist among them—an expert on the applications of economic analyses to business problems. He joined M.I.T. in 1956 after work with the International Monetary Fund and the Columbia Broadcasting System and teaching at Harvard, his alma mater. Holland, a specialist in public and business finance, has been at the Sloan School since 1958; he was a long-time member of the staff at the National Bureau of Economic Research and has consulted widely on public and corporate financial problems. Robinson has been the Sloan School's expert on international business since joining the faculty in 1972; earlier he had overseas economic and writing assignments. Widely honored for her work on minority economic labor problems, Wallace came to Sloan as a visiting professor in 1973 and two years later became full professor. She holds degrees from Yale and brought a varied background in economic and social research to the Institute.

Sloan Fellows

Colby H. Chandler, S.M.'63, chairman and chief executive officer at Eastman Kodak Co., Rochester, N.Y., received the third annual Community Award given by the State University of New York at Brockport. Chandler was cited for "his commitment to education and his demonstrated belief in the importance of the individual in helping to build a better society." . . . **Kenneth R. Hootnick**, S.M.'63, formerly president of Denver-based Butler Computer Graphics, has joined DICOMED Corp., Minneapolis, Minn., as executive vice-president and chief operating officer. DICOMED designs, manufactures and markets high-performance computer graphics products used in information communication.

Christopher B. Roberts, S.M.'85, director of venture financing of the Center for Space Policy, Cambridge, and chief financial officer for Spacehab, received a 1985 National Excellence Recognition Award from the Space Foundation. . . . **David Znaty**, S.M.'79, writes that he is "general manager of the Société de Gestion et d'Informatique Publicis; expert in computer science for the Appeal Court of Paris; and Chargé de Cours à l'Ecole Centrale des Arts and Manufactures." . . . Sister **Kathleen Natwin**, D.C., S.M.'76, has been named assistant to the president for planning and government relations of the Archdiocese of Boston Catholic Health Care System. Sister Kathleen will be responsible for strategic planning, clinical services planning, physician recruitment, and free care funding. Formerly she was president of St. Margaret's Hospital for Women, a 146-bed teaching hospital in Boston.

Senior Executives

James O. Zane, '82, president and general manager of EG&G Idaho, and has recently been named to the additional post of vice-president of the parent firm, EG&G, Inc., Wellesley, Mass.

. . . **Carlo J. Bosshart**, '70, writes, "Since 1983 I am a happy retired human being. Since last year, my wife and I have been living in Spain and travelling quite a lot through other countries and continents. That means that our life and interests changed quite a bit."

Henry E. Miller, '77, of Sun City, Ariz., who retired (1982) as assistant vice-president of Corporate Operating Affairs of Armc, Inc., passed away on May 22, 1986. Miller was a life member of the American Iron and Steel Institute and had served a term as chairman of the American Iron and Steel Engineers. . . . **Dale T. Caddy**, '79, who was an officer of Marathon Oil Co., Bridgeport, Ill., passed away on April 15, 1983; no further details are available.

Management of Technology Program

Milton Baker, S.M.'86, wrote in June that he had negotiated with his boss at General Motors for a long-needed vacation and would be returning to work in early July. . . . **Eugene Huang**, S.M.'85, called for a chat in August while he was back in Boston for his brother's wedding reception. He was looking forward to an upcoming white water rafting trip.

James Ishikawa, S.M.'85, called in August for a couple of classmate addresses and happened to mention he'd decided to get married! But he failed to tell us when and to whom. We want to send our congratulations anyway! . . . **Richard P. Percoski**, S.M.'86, called in July and admitted it was great to have weekends again after his year in the program! He also admitted it was a little slow getting back into the swing of work. . . . Jane Morse received a very nice and newsy letter in June from Susan Rimmer, **David Rimmer**'s (S.M.'86) wife. Their second baby was born in early March, a little girl named Ceri (pronounced "Kerry," Susan says) Angharad. It sounds as though her older sister, Lucy, adores her and that the house will never be silent with the both of the

chattering away! Susan reports that David has been very busy organizing the new Integrated Manufacturing Systems Department at Pilkington PE.

Katherine L. Rowe, S.M.'86, announced her marriage on July 5 to Steve Fox. They are living in Everett, Wash. . . . **Ralph J. Salvucci**, S.M.'86, called in July. He is back at Wright-Patterson Air Force Base where, he says, his thesis "was a big hit!" I guess his xeroxing expenses were way up. He said his family is doing fine and they seem, so far, glad to have him back!

Kim-Chinh Tran, S.M.'86, phoned us in August after a long visit home to Texas with his family. He is really enjoying his new position at Westinghouse as a principal analyst—technology acquisition in the Technology System Division. He hoped to be coming back to the Boston area on business soon. . . . **Graydon M. Wheaton**, S.M.'86, and his wife, Iris, were in a moped accident while vacationing on Nantucket in July. Iris was unhurt, but Graydon was in Massachusetts General Hospital for a couple of weeks after an operation. He was discharged July 30 and is recuperating well at home.—Jane Morse, Program Manager, Management of Technology Program, M.I.T., Room E52-125, Cambridge, MA 02139

XVI AERONAUTICS AND ASTRONAUTICS

After a teaching career at M.I.T. that began in 1944, Professor **Rene Miller** reached retirement last June; he's continuing beginning this fall on a part-time basis. Miller is an authority on helicopters and on aerodynamics, but he's also an expert in flight transportation, being the H. N. Slater Professor Emeritus in that field. Miller was head of the department for a decade beginning in 1968.

James K. Marsteller, S.M.'47, received a Distinguished Alumnus Award (June 1985) from Davis and Elkins College, his undergraduate alma mater.

. . . **Paul Ronney**, Sc.D.'16, has joined the Department of Mechanical and Aerospace Engineering at Princeton University. Ronney was formerly a resident research associate at the NASA Lewis Research Center, Cleveland. . . . Professor **Robert C. Seamans**, Sc.D.'16, senior lecturer in the department at M.I.T., has been elected to the Board of Overseers at New England Medical Center.

. . . **Kent Kresa**, E.A.A.'66, formerly group vice-president of Northrop's Aircraft Group and head of Northrop's Research and Technology Center, has been named senior vice-president—technology development and planning, for Northrop Corp., Los Angeles.

John K. Einhorn, S.M.'85, received the 1985 William E. Jackson Award given by the Radio Technical Commission for Aeronautics. Einhorn was cited for his master's degree dissertation "Probabilistic Modeling of Loran C for Non-Precision Approaches." . . . **James W. Mar**, Sc.D.'49, Jerome C. Hunsaker Professor of Aerospace Education at M.I.T. is serving on the National Research Council's panel of experts to "provide technical assistance to the NASA administrator on the design and construction of an improved solid rocket booster system for the space shuttle."

John F. McCarthy, Jr., '50, corporate vice-president and general manager of the Northrop Corp., passed away last February. McCarthy has been associated with the National Aeronautics and Space Administration, where he received a Distinguished Service Medal for his work, before joining Northrop.

Albert K. Showalter, '36, of Georgetown, Del., passed away on March 15, 1986. Showalter served (for 43 years) as a government meteorologist for the U.S. Weather Service, retiring as a senior physical scientist in 1972. . . . Brigadier General **Ernest Moore**, '37, associated with Clarkson College of Technology, Potsdam, N.Y., passed away in 1981; no further details are available.

XVII POLITICAL SCIENCE

Anne Cahn, Ph.D.'71, is executive director of the Committee for National Security, Washington, D.C.—described as “a bipartisan educational group that wants to moderate the arms race.” For the past four years, the group has held conferences around the country designed to educate women about national security and arms control. . . . Deborah R. Hensler, Ph.D.'73, has been promoted to research director of The Rand Corp.’s Institute for Civil Justice, Santa Monica, Calif., designed to conduct policy analysis and research on the American civil justice system. Hensler has been a member of its analytic staff since the founding of the Institute in 1979.

Daniel Rich, Ph.D.'72, professor of urban affairs at the University of Delaware, was presented an excellence-in-teaching award at the University's annual Honors Day last May 13.

XVIII MATHEMATICS

Hilliard Roderick, S.M.'44, a former director of the Organization for Economic Cooperation and Development (OECD), Paris, and an active campaigner against nuclear war, passed away on May 29, 1986. Roderick served with OECD from 1965 until 1978, working chiefly in the field of environmental policy. Later he was a visiting professor of world peace at the Lyndon B. Johnson School of Public Affairs at the University of Texas, Austin (1982-83), working on crisis management to prevent nuclear war. Roderick's research resulted in his book *Crisis Management: Avoiding Inadvertent War* and to his formation of the Hilliard Roderick Foundation for Prevention of Inadvertent Nuclear War. . . . John M. Gottman, S.M.'64, has joined the faculty of the University of Washington, Seattle, as professor of psychology in the College of Liberal Arts. . . . Two alumni of the department were awarded fellowship by the National Science Foundation: Ethan S. Devinatz, Ph.D.'85, at the University of Chicago; and Joseph F. Johnson, Ph.D.'83, at the University of Utah.

Professor Richard M. Dudley of M.I.T. was a member of the National Research Council's panel convened to provide the state-of-the-art report on the mathematical sciences published early this year. The conclusion: “We are in a dynamic period of mathematical discovery. (Already), mathematics is a fundamental driving force in the worldwide progress that is altering the economic, political, and social balance among nations. It is essential for the U.S. to maintain momentum in mathematics if we are to maintain our overall competitiveness in other areas.”

XXII NUCLEAR ENGINEERING

Donald H. Korn, S.M.'60, is a senior vice-president of Independence Investment Associates, Inc., Boston, responsible for new business strategy and marketing. Formerly Korn was a senior management consultant for Arthur D. Little, Inc., Cambridge; he is co-author of several books, including: *Acquisition and Corporate Development* (Heath, 1981); and *The Handbook for Professional Managers* (McGraw-Hill, 1985). . . . Elia P. Demetri, S.M.'62, has been promoted from manager of the Thermal Systems Group to director of research and development at Advanced Mechanical Technology, Inc., Newton, Mass. He will direct programs and marketing of contract research.

TECHNOLOGY AND POLICY PROGRAM

Thomas Lot, S.M.'83, is now product manager for Europe for educational packages, Texas Instruments, in France.—Richard de Neufville, Chairman, Technology and Policy Program, M.I.T., Room 1-138, Cambridge, MA 02139

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J.R. Zacharias



H.R. Isaacs

Jerrold R. Zacharias, 1905-1986 Major Figure in Physics, Education

Jerrold R. Zacharias, Institute Professor Emeritus and professor of physics emeritus, who was noted equally for important contributions to atomic and molecular physics, science education, and national science policy, died suddenly at his home in Belmont, Mass., on July 16. He was 81.

Zacharias first rose to prominence in physics as director of the Engineering Division of the Manhattan Project during World War II, an assignment he undertook on leave from the M.I.T. Radiation Laboratory. He had come to the Institute in 1940 to head the laboratory's work on radar transmitter components.

Returning to M.I.T. after the war, Zacharias became professor of physics and director of the Laboratory for Nuclear Science, one of the pioneering interdepartmental laboratories. At the same time he continued the high-precision studies of radio-frequency spectra that he had begun at Columbia University.

Meanwhile, Zacharias's intense concern for scientific education led him to form the Physical Science Study Committee (PSSC) in 1956 and through it to undertake a major restructuring of high school physics curricula. The result was the PSSC physics course, adopted almost immediately upon its completion in 1958 by some 360 secondary schools. By 1970 PSSC physics was being taught to more than 200,000 students in 5,000 schools.

Noting that PSSC was organized a year before the Soviets stunned the U.S. with the launch of Sputnik, the *New York Times* said Zacharias's work helped swing national sentiment "behind the teaching of science as never before." As recently as 1980, concerned that the nation was investing too much in large-scale science and too little in science education, Zacharias was talking about starting a new reform movement. "I'm still crazy enough to try it," he said.

Zacharias's concern for national and international policy issues in which sci-

ence played a major role led him to participate in a number of M.I.T.-based studies of technical and defense issues—Project Lexington on nuclear-powered aircraft (1948), Project Hartwell on undersea warfare (1950), Project Charles on air defense (1951), and others. He was associate director of Project Lincoln, the study of the DEW (distant early warning) line out of which grew M.I.T.'s Lincoln Laboratory.

Tributes to Zacharias were only beginning to arrive as this issue of the *Review* went to press. President-Emeritus Jerome B. Wiesner described Zacharias as "my closest friend (and) most valued mentor. . . . M.I.T. today reflects his wide interests, his regard for students, . . . and his commitment to quality."

Frank Press, president of the National Academy of Sciences, placed Zacharias in a small group of distinguished physicists "dedicated to the notion that scientists could, and should, contribute to the solution of a broad range of national and international problems."

Born in Jacksonville, Fla., Zacharias held three degrees (A.B. 1926, M.A. 1927, and Ph.D. 1932) from Columbia University, where he taught at Hunter College before coming to M.I.T.

A memorial service for Jerrold Zacharias will be held at M.I.T. in the fall.

Harold R. Isaacs, 1910-1986: Journalist Turned Teacher

Harold R. Isaacs, professor of political science emeritus who came to M.I.T. in 1965 after a career in journalism in New York, Washington, and southeast Asia, died on July 9 at Massachusetts General Hospital following heart surgery; he was 75.

Isaacs was the author of nine books, many of them on China. He went to China following graduation from Columbia College in 1930 and by 1932 had founded an English-language weekly in Shanghai, *The China Forum*. Its persistent criticism of the Chiang Kai-shek regime led Isaacs to leave Peking and to write his first book, *The Tragedy of the Chinese Revolution*. Isaacs' most recent

book, *Re-encounters with China* (1985), reported on a 1980 trip to China and a series of interviews with people he had known in the 30s.

Before 1950 Isaacs served *Newsweek* as a reporter in Washington and a correspondent throughout southeast Asia; as associate editor he was responsible for establishing the editorial programs for *Newsweek's* international editions.

The award of a Guggenheim Fellowship in 1950 launched Isaacs' academic career, and by 1953 he was a research associate in the M.I.T. Center for International Studies. He joined the faculty in 1967, retiring in 1976. Isaacs' colleague, Professor Lucian W. Pye, describes him as "a vital force in provoking intellectual curiosity about world problems and also a lively role model for M.I.T. students. . . . Out of his background in journalism and a youthful phase of radical politics," said Pye, "came an extraordinary combination of rigorous reasoning—combative if necessary—and compassionate concern for the problems of others."

Dana L. Farnsworth, 1905-1986

MI.T.'s medical director from 1946 to 1954, Dana L. Farnsworth died in a convalescent home in Watertown, Mass., on August 2; he was 81.

It was while he was director of the M.I.T. Medical Department that Farnsworth expanded his reputation as a pioneer in the development of comprehensive college health programs. Farnsworth had begun this work in a similar post at Williams College. He left M.I.T. to head the University Health Services at Harvard, where he was also Henry K. Oliver Professor of Hygiene.

Farnsworth entered Harvard Medical School (class of 1933) from West Virginia University. Trained in psychiatry, he was twice chairman of international conferences on student mental health.

Paul F. Hellmuth, 1918-1986

Paul F. Hellmuth, '47, a prominent Boston lawyer whose extensive public service included the co-chairmanship of the M.I.T. Leadership Campaign in the 1970s, died of an apparent heart attack in his Cambridge home on August 3; he was 68. He was a member of the M.I.T. Corporation for a five-year term starting in 1974.

Hellmuth was for 25 years a managing partner of the Boston law firm of Hale and Dorr, where he is credited with bringing "New-York-law-office-style efficiency" to Boston. But he is better remembered for his role in countless Boston philanthropic activities. "Whenever an adept fund-raiser was needed

by one of Boston's civic organizations, Mr. Hellmuth's name topped the list," wrote Edgar J. Driscoll, Jr., in the *Boston Globe*.

Deceased

The following deaths have been reported to the Alumni Association since the *Review's* last deadline:

Franklin T. Towle, '08; July 16, 1986; West Roxbury, Mass.
John B. MacNeill, '13; June 4, 1986; Butler, Penn.
Paul H. Duff, '16; June 21, 1986; Peabody, Mass.
Arthur D. Dickson, '17; May 15, 1986; Sebago Lake, Maine.
Alexander H. Kenigsberg, '17; October 6, 1985; Philadelphia, Penn.
Edward N. Little, '18; April 27, 1986; Englewood, N.J.
Louis J. Grayson, '19; April 30, Bethesda, Md.
Milton A. Loucks, '19; June 4, 1986; Snyder, N.Y.
Victor F. Van Neste, '22; March 22, 1986; Milton, Mass.
Charles E. Mongan, Jr., '23; July 4, 1986; Cambridge, Mass.
George F. Nesbitt, Jr., '25; February 26, 1986; Sandy Spring, Md.
Joseph T. Lusignan, '24; July 20, 1986; Menlo Park, Calif.
Richard W. Steenbruggen, '24; November 5, 1984; Brattleboro, Vt.
John Cornwall, '25; June 4, 1986; Midland, Tex.
William P. Gee, '26; August 27, 1985; Buck Hill Falls, Penn.
Ernest K. Warburton, '26; April 27, 1986; Hardwick, Mass.
Thomas Herbert Darnell, '27; June 10, 1986; Memphis, Tenn.
Joseph W. Gaffney, '28; May 14, 1986; Oak Brook, Ill.
Nicholas P. Stathis, '29; June 27, 1986; Stuart, Fla.
Leslie H. Ferrier, '30; March 27, 1986; Guelph, Ontario, Canada.
William S. Reeder, '30; June 22, 1986; Groves, Tex.
D. Jack Allia, '31; June 15, 1986; Worcester, Mass.
Otto C. Kohler, '31; June 12, 1986; South Hadley, Mass.
Helen F. Tucker, '33; February 25, 1986; Sarasota, Fla.
Claude P. Beaubien, '34; April 7, 1986.
Albert G. Kern, Jr., '34; June 19, 1986; Knoxville, Tenn.
Kenneth F. Ryder, '34; July 3, 1986; Longmeadow, Mass.
Raymond H. Coombs, '35; November 19, 1985; Los Gatos, Calif.
Robert W. French, Jr., '35; June 9, 1986; Concord, Mass.
John Churchill Austin, '36; August 8, 1983; San Diego, Calif.
Ernest Moore, '37; 1981.
Joseph I. Bluhm, '41; March 5, 1986; Southeaston, Mass.
Harry C. Maynard, '42; June 17, 1985; Bellevue, Wash.
Williard Roderick, '44; May 25, 1986; Washington, D.C.
David W. Jones, '46; February 8, 1986; Pittsburgh, Penn.
William Duncan, '47; April 15, 1986; Littlestown, Penn.
M. Roy Burgwardt, '48; April 4, 1986; Buffalo, N.Y.
Rockwell Kent III, '48; April 8, 1986; Upton, Mass.
Seymour Stillman, '48; December 22, 1985; Flushing, N.Y.
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PUZZLE CORNER

ALLAN J. GOTTLIEB

Can You Solve This "Maximdidge"?

For the information of new readers, I review the ground rules under which this department is conducted.

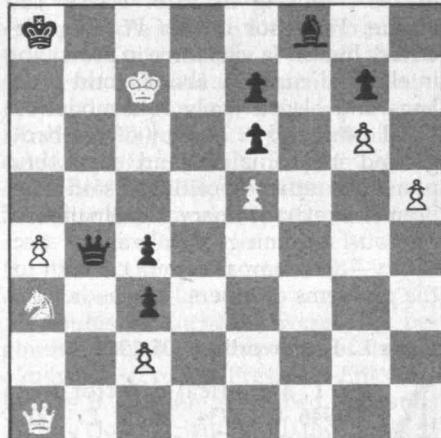
In each issue I present five regular problems (the first of which is chess, bridge, or computer-related) and two "speed" problems. Readers are invited to submit solutions to the regular problems, and three issues later one submitted solution is printed for each problem; I also list other readers whose solutions were successful. For example, solutions to the problems you see below will appear in the February/March issue. Since I must submit that column sometime in November, you should send your solutions to me during the next few weeks. Late solutions, as well as comments on published solutions, are acknowledged in the section "Better Late Than Never" in subsequent issues.

For "speed" problems the procedure is quite different. Often whimsical, these problems should not be taken too seriously. If the proposer submits a solution with the problem, that solution appears at the end of the same column in which the problem is published. For example, the solutions to this issue's "speed" problem are given below. Only rarely are comments on "speed" problems published or acknowledged.

There is also an annual problem, published in the first issue of each new year; and sometimes I go back into history to republish problems that remained unsolved after their first appearance.

Solutions

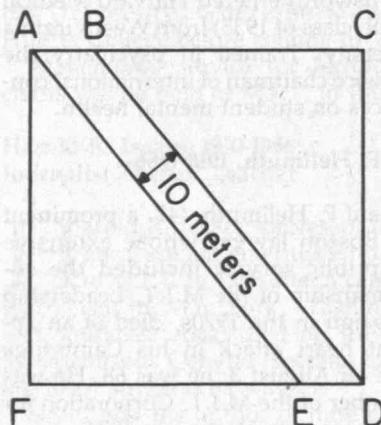
OCT 1. We begin with a chess problem from *The Tech*, M.I.T.'s student newspaper. White is to move and mate in 10.



OCT 2. Nob. Yoshigahara wants to know the smallest positive integer A such that the first 10 digits in \sqrt{A} consist of 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0, each occurring exactly once.

OCT 3. the following problem is from Jim Landau:

A road 10 meters wide cuts not-quite-diagonally across a 1-kilometer square as shown. What is the area of triangle AEF?



OCT 4. Our next problem, a "maximdidge" from Neil Macdonald, first appeared in *Computers and People*:

A maxim (common saying, proverb, some good advice, etc.) using 14 or fewer different letters is enciphered (using a simple substitution cipher) into the

10 decimal digits or equivalent signs, plus a few more signs. To compress any extra letters into the set of signs, the encipherer may use puns, minor misspellings, equivalents (like CD or KS for X), etc. But the spaces between words are kept. The problem is to decipher the following:

Ωθμ ωΩμτ θΩΔ δμφΔ Δζμ
ζΩτμ ΔζφΔ ΔζΩΔτ.

OCT 5. We end this section with an infamous solid geometry problem submitted by George Byrd:

A regular pyramid and a regular tetrahedron both have sides of the same length. Place one face of the tetrahedron on one triangular face of the pyramid so that the three vertices of both faces coincide. How many faces does the resulting solid figure have?

Speed Department

SD 1. The short sides of three equal 45-45-90 triangles are joined to form a three-sided pyramid whose base is an equilateral triangle. What is the slant angle between the sides and the base of the pyramid? (It's easier for a regular tetrahedron.)

SD 2. We close with a puzzle that appeared in *IEEE Potentials*. What is the missing number in the following sequence?

10, 11, 12, 13, 14, 15, 16, 17, 20, 22, 24, —, 100, 121, 10000.

Solutions

M/J 1. White is to play and win.



A poetic solution from John Bobbitt:

White moves his Bishop to the square R6,
And tells Black that he's in Check!

Black moves his King to the square N1,
And says, "Oh, what the heck."

"I cannot move King to Bishop 3
Because you'll fork my Queen.

Moving Bishop down to space N2
Is worse—you'll take it clean."

Move 2 for the White is with his Queen.
He moves it back to N3.

Black slides his King to the square R1.
It's either there or B3.

King to B3 is a loser, we know,
Because of the fork by White's Knight.
But now Black's King is really trapped,
Much to the delight of White.

White now moves his Bishop to square N7,
And says, "Check on you, my friend."
Black's Bishop takes White's, and Black then replies,
"You lost it. We're nearing the end."

"The end is in sight," White quickly replies.
"Knight to Queen 7 is right."

I now have two ways to get a checkmate
Or capture your Queen with my Knight.

"If you move your Queen along the back row
Knight to N6 gives a mate.

Or push up your Queen so it leaves the back row,
And I get you with Queen to Knight 8.

"Or leave your Queen there and move N or B;
Checkmate no longer is mine.

But Knight takes Queen is a winner for me—
it's only a matter of time."

Black looks and frowns and topples his King,
And offers his hand to White.

The moves from above summed up below,
And with that I bid you, "Good Knight."

1. B-R6 ch K-N1

If 1. . . . K-B3, then 2. N-K6 ch wins the Queen

2. Q-N3 ch K-R1

3. B-N7 ch! BxR forced

4. N-Q7! Resigns

Also solved by Jim Landau, Matthew Fountain, Richard Hess, Thomas Chang, and the proposer, Bob Kimble.

M/J 2. A BB 2 mm. in diameter sits atop a "superball" 10 cm. in diameter, the center of which is 1 meter above the ground. If both objects are released simultaneously, what is the maximum possible height the BB can attain upon rebound?

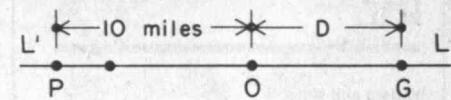
The following solution is from Matthew Fountain: I vote for 8.65 meters. I take superball to be a ball that can bounce as high as it drops. This implies that upon leaving the ground all parts of the ball must have the same speed, as otherwise the ball will be vibrating about its center of gravity, with the energy associated with this vibration subtracted from that which would otherwise be available for elevating the superball. Superball and the ground must be extremely hard, as any appreciable displacement would cause the ball or ground to vibrate. With these assumptions, it follows that superball will rebound so quickly that the BB will act as if it has fallen upon a surface rising with the speed that superball hits the ground. The BB will therefore rebound from superball as if it had approached superball with twice the speed that superball hits the ground. Consequently the BB may not rebound with more than three times this speed when measured with respect to the ground. As kinetic energy varies as the square of velocity and potential energy varies directly as the height, the BB will not be flipped more than nine times as far as the ball drops. Nine times 0.95 plus 0.10 equals 8.65. In my very crude experiments with a very old golf ball and an upside down thumbtack, I found the thumbtack sometimes to bounce to what seemed to be at least three times the height of the drop, even though the ball rebounded about half the height of the drop. My eyeball measurements were rather crude, as the drops were of the order of one inch and my measuring scale was two bricks. I interpret these results to mean that the top surface of this ball vibrates so that the BB is tossed upward. The thumbtack does not bounce at all well off the ball.

Also solved by Dennis White, Harry Zaremba, Jim Landau, Peter Kramer, Richard Hess, Thomas Chang, and the proposer, Bruce Calder.

M/J 3. From the front to the rear of an advancing army detachment was 10 miles. A rear guard messenger, dispatched to the guard house directly behind his position in the line of march, returned

without loss of time and then proceeded immediately to the vanguard and again returned. He then noted that he had overtaken his guard 10 miles from the starting point and that the time spent on each errand had been the same. How far was the guard house from the starting point, and how far did the messenger travel altogether?

The following solution is from James Abbott:



Let $L' - L$ represent the line of march, O the starting point, G the guard house, and P the point at which the messenger overtakes the rear guard. Let T_0 be the instant he starts toward the guard house and T_1 the instant he reaches point P . Let V_m be the speed of the messenger along the line of march and V_a the speed of the army detachment. It is assumed that these speeds remain constant for the duration of both errands. Then the time required for the first "errand" is

$$T_1 - T_0 = (2D + 10)/V_m.$$

To reach the vanguard his speed relative to the detachment is $V_m - V_a$. The time he takes to reach the vanguard would be:

$$t_g = 10/(V_m - V_a).$$

On the return leg his relative speed becomes $V_m + V_a$ and the time on the leg would be

$$t_r = 10/(V_m + V_a).$$

By definition, the sum of these two times is equal to $T_1 - T_0$, or

$$10/(V_m - V_a) + 10/(V_m + V_a) = (2D + 10)/V_m.$$

A second relation is given by the fact that the detachment traveled 10 miles during the period $T_1 - T_0$:

$$T_1 - T_0 = 10/V_a.$$

Equating the two expressions for $T_1 - T_0$ gives $(2D + 10)/V_m = 10/V_a$.

Rearranging and reducing to lowest terms yields $V_a/V_m = 5/(D + 5)$.

Equations (1) and (2) give us a system of two equations with apparently three unknowns. However, since both V_a and V_m are constants (by assumption) it follows that their ratio V_a/V_m must also be a constant. Let this constant be R ; then $V_a/V_m = R$ and $V_a = RV_m$. Substituting RV_m for V_a in (1) gives $10(V_m - RV_m) + 10/(V_m + RV_m) = (2D + 10)/V_m$.

Cancelling common factors (V_m in the denominators, 2 in the numerators),

$$5/(1 - R) + 5/(1 + R) = D + 5. \quad (3)$$

Placing the left-hand terms over a common denominator $(1 - R^2)$ and clearing of fractions,

$$5(1 + R) + 5(1 - R) = (D + 5)(1 - R^2) \text{ or},$$

$$(D + 5)(1 - R^2) = 10. \quad (4)$$

Solving (4) for R^2 ,

$$R^2 = (D - 5)/(D + 5).$$

Substituting R for V_a/V_m in (2) and squaring both sides,

$$R^2 = 25/(D + 5)^2.$$

Equating two expressions for R^2 and simplifying,

$$D^2 - 25 = 25$$

$$D = (50)^{1/2} = 7.701 \text{ miles (to 3 decimal places).}$$

To get the total distance the messenger traveled, we note that on the first "errand" he travels a distance $(2D + 10)$ or 24.142 miles. Since his speed is assumed constant and the times for both "errands" are the same, it follows that he must travel the same distance for the second "errand." Hence the total mileage is

$$2 \times 24.142 = 48.284 \text{ miles.}$$

Although not called for in the problem statement, it is interesting to solve for R and consider the practical implications. It turns out that $R = 0.4142$ and its reciprocal is 2.4142. This means that the messenger must travel almost 2.5 times the speed of the marching army. Since this speed is a little over 3 mph, the messenger must be either a Superman or else have some kind of mechanical assistance (possibly a bicycle)?

Also solved by Dennis White, Harry Zaremba, Jim Landau, Jim Rutledge, Jules Sandock, Matthew Fountain, Mary Lindenberg, Michael Strieby, Richard Hess, Steve Feldman, and Thomas Chang.

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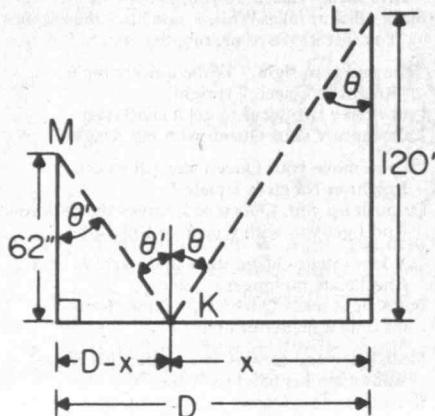
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M/J 4. A supermarket shopper whose eyes are 62 inches above the ground notes that the glossy linoleum floor of an aisle reflects the fluorescent lamps installed crosswise to the aisle 10 feet above it. As the shopper moves down the aisle at a uniform rate of 42 inches per second, the reflected images move as well. When a lamp is a horizontal distance D ahead, what is the speed of its image in the floor?



M is the shopper's eyeballs.

L is the light.

K is the image of the light on the floor.

If we find x , we can then find the speed at which K travels, as both K and M reach the vertical line under L at the same time. We note from physics that

$$\sin \theta = x/\sqrt{120^2 + x^2}$$

$$\sin \theta' = (D-x)/\sqrt{62^2 + (D-x)^2}$$

$$x/\sqrt{120^2 + x^2} = (D-x)/\sqrt{62^2 + (D-x)^2}$$

By simplifying for x we get

$$x = (120/182)D = .65934D$$

Now distance = rate \times time. But the time for M to travel D is the same as the time for K to travel x . Solve for t and we get the following:

$$D/R_D = x/R_K$$

Solving for R_K gives

$$R_K = (x \times R_D)/in$$

Plugging in the variables knowing $R_D = 42$ in/sec we get

$$R_K = (.65934 D)(42)/D, \text{ so } R_K = 24.69228 \text{ in/sec.}$$

Also solved by Dennis White, Greg Spradlin, Harry Zaremba, Jim Landau, Jim Rutledge, John Bobbitt, Jules Sandock, Matthew Fountain, Richard Hess, Thomas Chang, and the proposer, Phelps Meaker.

M/J 5. Fill in the boxes with the digits 0, 1, 2 . . . 9.

$$\boxed{\quad}\text{min} : \boxed{\quad}\text{sec} \times \boxed{\quad} = \boxed{\quad}\text{hrs} : \boxed{\quad}\text{min} : \boxed{\quad}\text{sec}$$

Steve Feldman wrote a computer program to check all combinations and list those that worked. The result was the list printed below:

- 1) 15:69 \times 3 = 0:48:27 8:67:54 \times 8 = 9:03:12
- 2) 18:49 \times 3 = 0:56:27 9:69:23 \times 7 = 8:05:41
- 3) 18:74 \times 9 = 2:53:06 10:76:98 \times 4 = 5:10:32
- 4) 30:97 \times 8 = 4:12:56 11:78:09 \times 4 = 5:12:36
- 5) 31:97 \times 8 = 4:20:56 12:79:08 \times 4 = 5:16:32
- 6) 45:79 \times 8 = 6:10:32 13:82:19 \times 3 = 4:06:57
- 7) 50:42 \times 9 = 7:36:18 14:91:73 \times 4 = 6:08:52

The only solution that he feels could unequivocally be called legitimate would be number 7. Solution 2 might also be considered valid by some people. He would not call any of the others valid.

Also solved by David Simen, Donald Savage, Hy Tran, Jim Landau, John Bobbitt, Jules Sandock, Mary Lindenber, Matthew Fountain, Steve Feldman, and the proposer, Nob Yoshigahara.

Better Late Than Never

1986 JAN 3. John Langhaar has responded, and Walter Nissen believes that the solution given does not work for $p = 17$. However, if one interprets the repeating part of the decimal to include the leading zero, all seems well.

JAN 4. Walter Nissen noticed that the problem was reprinted incorrectly. The solution is correct, but naturally for the original problem.

F/M 1. Charles Larson has responded.

F/M 4. Howard Zeidler has responded.

F/M 5. Stefania Anderson has responded, and the following submission is from Stanley Liu:

The following references to the recreational mathematical literature may be of some interest. It turns out that the number 6174, along with its unusual status as the unique fixed point of all four-digit integers (whose digits are not all identical) under repeated (maximum difference) reordering-subtraction operations, was first discovered and discussed by D.R. Kaprekar in 1949. Most appropriately, many subsequent writers have referred to 6174 as *Kaprekar's number* in honor of its original discoverer. I myself have been fascinated by Kaprekar's number and the associate Kaprekar operations since the late 1960s. I also read with interest the various attempts to generalize this problem to other multiple-digit numbers and to numbers in different bases. I find the discussions by Charles Trigg (in 1970 and 1971) most comprehensive. He classified all four-digit integers (not a multiple of 1111) into one of 54 representations by two "predictive indices" (i.e., the difference between the largest and smallest digits and that between the middle ones) and listed the number of Kaprekar operations required before the self-regenerative 6174 is reached. He also discussed five-digit numbers (and many others) and presented results in number bases other than ten. (One can easily carry out some of these calculations nowadays on a microcomputer, as I have done and verified his table for 6174.) I hope one day I will have more to say on this matter and add to the existing literature.

APR 2. Jim Landau notes that $\int_0^L \sin(t^2) dt$ is often used by electrical engineers to get a wave decaying in both wavelength and amplitude.

Proposer's Solutions to Speed Problems

SD 1. Let L equal an edge of the base; the slant height is then $L/2$. A vertical line through the peak of the pyramid has its foot on a perpendicular bisector of the base, $2/3$ of the distance from the corner of the base. The angle is $\cos^{-1}(0.866L/3)(L/2) = \cos^{-1}(0.5774) (54.7^\circ)$. For the tetrahedron: $\cos^{-1}(0.3333) (70.53^\circ)$.

SD 2. 31. Each number is sixteen expressed in different bases. \square

BALTIMORE: That's not true. Just look at, for instance, the Hastings Center. There's an organization that has devoted itself for the last 20 years to serious concerns about modern biology. And there are many other groups who have focused for some time on the ethical, social, and legal implications of biology.

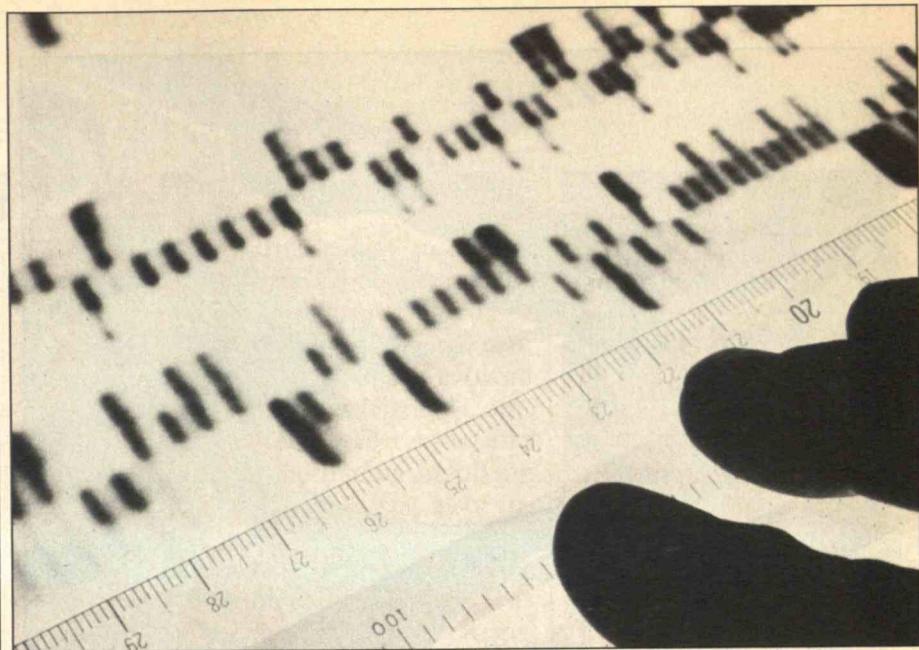
TR: Isn't there cause for concern about releasing more complicated genetically altered organisms into the environment—organisms that would not be found naturally and therefore could take over?

BALTIMORE: We certainly need to examine every case on its merits to decide when concern is reasonable and when it's not. But generally I don't think such organisms will pose a problem for a number of reasons. First, the manipulations we're doing in the laboratory are minimal compared with what evolution has done. Evolution has made you and me out of a bacterium, and we're not doing anything close to that.

TR: But evolution took place over millions, even billions of years and it occurred naturally. Humanity was not in control of evolution the way it is in control of genetic engineering.

BALTIMORE: That's true. We can work very fast in the laboratory, while natural selection is inevitably a slow process. We can also put together genes from disparate species that don't ordinarily come in contact with one another naturally. So that gives us a new dimension. But whether we're going to do anything fundamentally different and make an organism that is stronger than anything previously seen or more virulent is very doubtful. I think the principles of evolution will hold. It takes very stringent selection to produce something that will do better in a natural environment than what exists before.

TR: If you put a rat growth hormone into a cow, you may not have to worry about that cow adapting to a natural environment. But won't there be some down-the-line effect on the milk supply or something like that?



BALTIMORE: No. What there will be is a lot more milk from that cow.

TR: But is that healthy for the cow?

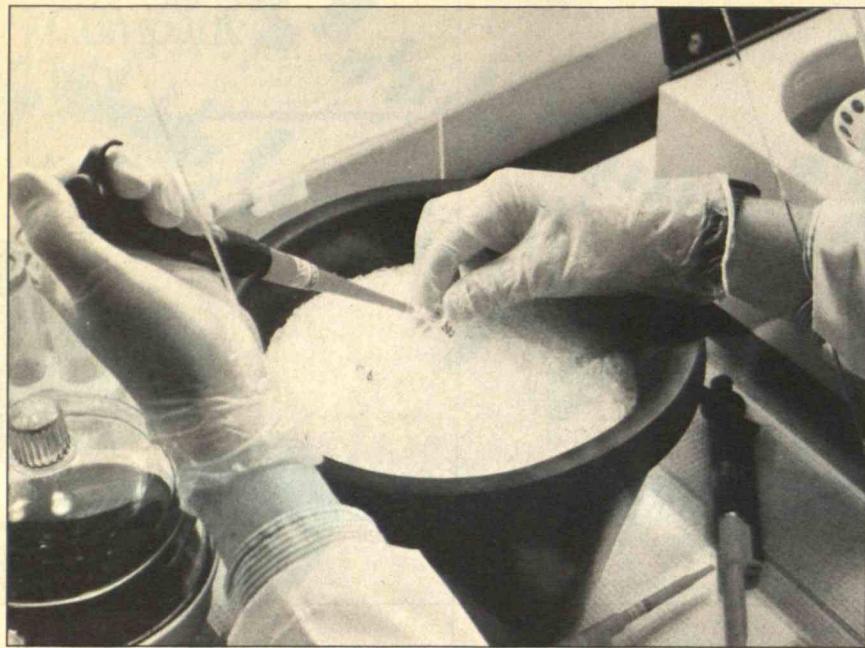
BALTIMORE: No, it's not healthy for that cow. But it's not healthy to be a dairy cow to start off with. And it's certainly not a danger to the environment. For years we have been modifying plants and animals to meet our demands using standard methods of breeding. We have done more to that cow by breeding it over generations than we would by injecting a growth hormone into it.

Let me give you a different example. The difference between a domestic dog and a wild dog is much greater than the differences we're creating in the laboratory—and that difference was created artificially by breeding dogs over generations. How about the nectarine? That's a hybrid between two existing fruits. We've been fooling around with genetics for a long time. When we breed, we fool around with all the genetics available to us through evolution, which is much wider in its variation than the single genes that we manipulate in the laboratory.

TR: Why then aren't people concerned about breeding?

BALTIMORE: Because it's been going on so long—it's like the GRAS [generally regarded as safe] rule used in regulating pharmaceuticals. Lots of drugs are al-

Scientists can identify the exact sequence of nucleotide bases—the chemical letters that make up all DNA—in a particular gene. They do so through electrophoresis, a technique that uses electric current to separate out the nucleotides, which are displayed as vertical bands on a gel (shown above). Once scientists know the nucleotide sequence, they can clone and even alter the gene.



The DNA probe is a particularly potent new technology that has a number of uses, including diagnosis. To confirm the identity of a virus in a patient, for instance, scientists can construct a DNA strand with a nucleotide sequence identical to that of the suspected virus. The synthetic strand is tagged with a radioactive isotope (as shown above) and introduced into the patient's bloodstream, where it acts as a probe, searching for its matching or complementary strand. If the virus is present, the two strands automatically join together, becoming the double helix present in every complete piece of DNA. The two strands can then be located and the diagnosis confirmed.

lowed to be on the market because they were grandfathered in under the GRAS rule. Aspirin, for instance; why hasn't it ever been tested? It was around for a long time before people started worrying about testing.

But the real reason we're not concerned is that none of the new strains has taken over the environment. In fact, all of the new strains are somehow crippled in comparison with the original "wild type."

TR: What is it that makes these artificially created organisms less able to survive naturally?

BALTIMORE: It's the other way around. What is it that allows something to grow in the wild? It's a conjunction of many traits that allow a plant or animal to get the nutrients it needs, reproduce itself, and live through occasional terrible circumstances such as drought or hurricanes. All of those traits have to be built in, and they're built in by evolution. When you start modifying a plant or animal, you inevitably move away from the optimal solution to something less than optimal.

As a result, the organisms that cause trouble are not the ones that breeder Luther Burbank created and they're not the ones that dog fanciers have bred. The real problem comes with the removal of an

organism from its naturally selected environment, away from the pests that control it. That's the really dangerous thing—the starling and gypsy-moth kind of situation. The gypsy moth, which was introduced in the United States in Medford, Mass., from Europe, had no natural predators here, and it went wild because it was extremely well adapted to a natural environment. In some years, gypsy moths eat up a significant fraction of the leaves in forests on the East Coast.

A Process the Public Can Trust

TR: Advanced Genetic Systems probably thought as you do that there were no conceivable ecological effects from releasing frost-free bacteria. Do you think the company was therefore right to disregard EPA guidelines and go ahead and test its ice-minus bacteria in the open air?

BALTIMORE: No, they shouldn't have done it. Whether or not the test was dangerous, they should not have done it because we have defined a category of experimental manipulations involving recombinant DNA that should be reviewed on a case-by-case basis before being used in the environment. Many of us argued in the early days of recombinant-DNA activities that such manipulations are really a mimicry of natural processes, and that it is silly to put aside everything involved with altered DNA and treat it separately. But silly or not, that has been done and agreed to and we're not going to turn that around.

Even if biotechnology is just seen as a symbol of everything else that has gone wrong with technology, there is an established process for dealing with genetically altered organisms and we have to follow it. The public is right to say they're not going to believe a specific individual or company who says a particular product is safe. It's a question of following a regulatory process that the public can trust. Because if they trust the process, and something is approved through that process, then they'll know it's okay.

TR: What did you think of the USDA's initial decision to approve the license for pseudorabies virus without consulting its advisory committee?

BALTIMORE: Maybe it never dawned on the Department of Agriculture that there was any established process to follow, or maybe they thought they could subvert the whole procedure. I don't understand what they were doing. It sounds unbelievable that the government could be so totally unaware of the whole history of the problem, but maybe they were. Maybe Saul Kit who developed the virus in Texas never made them aware. Maybe Saul himself was not aware of what he was doing. Or else it's perfectly possible that a variety of people were pulling fast ones.

TR: Because of the controversies over the ice-minus bacteria and the viral vaccine, some people have compared the nascent biotech industry to the nuclear power industry two decades ago.

BALTIMORE: Boy is that a mistake. First of all, the biotech industry has taken into account public concerns in a meaningful way—right from the beginning. That was certainly not true in the nuclear power industry or in any other industry. In this case a group of people raised questions about whether everything was safe at the first signs of a powerful new technique, and asked that a decision be made by a governmental body about what was appropriate and how we should go forward. It was technology assessment at the very inception of the technology—and that is highly unusual in this country.

TR: Are you referring to the moratorium on recombinant-DNA experimentation that the scientists themselves called for in the mid-1970s?

BALTIMORE: Yes. A number of us within the scientific community met here at M.I.T. and drafted what is known as the Berg letter [Nobel laureate Paul Berg chaired the group]. That letter asked that scientists not carry out certain kinds of experiments until some experts could really look at them and see whether they

were safe. That generated a moratorium and at the conference at Asilomar [in California], we drafted rough guidelines and a mechanism for making sure recombinant-DNA experiments were carried out in a safe and appropriate manner. From that conference, NIH guidelines evolved and the Recombinant Advisory Committee (RAC) was set up to review and approve research experiments involving recombinant DNA. RAC was also intended to modify the guidelines as knowledge about the field grew.

TR: So how would you say RAC was different from, say, the Nuclear Regulatory Commission?

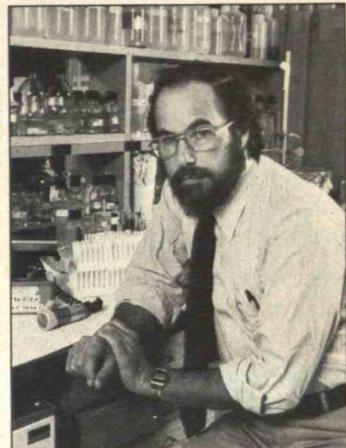
BALTIMORE: First of all, it was a voluntary review process. Molecular biologists in academia and industry voluntarily submitted themselves to the RAC jurisdiction from the beginning. That meant that the whole biotechnology industry developed within the context of concern about safety. To my knowledge, everyone in the industry was aware of that concern and was responding to it.

TR: Many scientists now question whether they should have bothered to go public with their concerns. They feel the issues they raised in the mid-1970s have been distorted by people such as Rifkin.

BALTIMORE: Many university scientists feel the whole Asilomar process burned them badly, and they don't want to see anything like that again. What started as an intellectual investigation ended up becoming a political circus. And the most outrageous moment of the circus was generated by Jeremy Rifkin at the National Academy of Sciences (in 1977), when he brought up the horrors of Nazi experimentation on unwilling human victims. That's idiocy. I understand that sort of thing as just the excesses of the process, and that the process is basically correct. But I can well understand my colleagues who say, "You're an idiot to open yourself up."

TR: But you feel it was worth it?

BALTIMORE: From my point of view, it was necessary and worthwhile. It devel-



The manipulations we're doing in the laboratory are minimal compared with what evolution has done.



The biotechnology industry has taken into account public concern right from the beginning. That was not true of the nuclear power industry.

oped public confidence in biotechnology, and I think the process under RAC jurisdiction worked very well. Both university laboratories and biotechnology companies knew that when they came to RAC, they were dealing with a process that involved a relatively fixed time period, and that had a history of people who really understood the technology and were making reasonable decisions. All the initial experiments by the biotechnology industry—the cloning and fermentation of interferon, insulin, and growth hormone, for instance—went through RAC, and that enabled the industrial work to move forward safely and rapidly.

RAC's major accomplishment, however, was that it was flexible enough to handle a moving situation. Keep in mind that the science of recombinant DNA was evolving so fast in the late 1970s and 1980s that anything set in stone would have immediately impeded new scientific developments. When you try to write into law what should and shouldn't be done in a fast-moving field, sometimes you end up inhibiting things you never imagined you would—and doing precisely the opposite of what you intended. But RAC was able to continually modify the guidelines as knowledge about biotechnology grew. That would never have happened if this research had been under purview of a regulatory agency.

TR: What specifically would have been inhibited by rigid regulation in the early 1980s?

BALTIMORE: A perfect example was the cloning, sequencing, and characterization of animal viruses—that is, identifying the viral genes and finding out what they do and how they're organized. This research was held up for a number of years because its original classification by RAC required extremely high containment facilities. Very few labs had such facilities. As a result, no work was done on viruses until we discovered that such research was safe to do without extreme precautions and modified the guideline.

If the original classification had been written into law, viral research would have been stalled for a much longer time. Once you make a law, it's very hard to change it.

TR: Can you give me a specific example of something constructive that came out of the viral research allowed by RAC?

BALTIMORE: The understanding of the AIDS virus. Scientists were able to identify the causative agent of AIDS rapidly because we knew so much about this kind of virus, largely as a result of recombinant-DNA work.

Why EPA Should Not Take Charge

TR: The new guidelines formulated by the Reagan administration have shifted much of the responsibility for reviewing the release of genetically altered products away from NIH to existing regulatory agencies. For instance, the EPA now decides whether to approve the release of live genetically altered organisms into the environment, and is also responsible for pesticides made by recombinant-DNA means. The Food and Drug Administration (FDA) is responsible for medical products produced by recombinant DNA, the USDA for approving recombinant-DNA products such as vaccines and growth hormones to be used on plants and animals, and the Occupational Safety and Health Administration (OSHA) for the safety of workers involved in recombinant-DNA work. Do you think this is the best approach?

BALTIMORE: No. I would have liked RAC to have primary responsibility for regulating all recombinant-DNA experimentation, including industrial activities—but not for regulating the end product itself. For instance, I think RAC should be responsible for approving field experiments involving the release of genetically altered bacteria and viruses. RAC members are much more knowledgeable about the ecological effects of such research than the bureaucrats at EPA. However, RAC shouldn't be wor-

trying about regulating the *products* of recombinant-DNA research, whether they be pesticides or new drugs or whatever. For instance, it's up to the FDA to regulate human growth hormone—to make sure it's used by children who suffer from pituitary dwarfism and not by parents who want a tall kid. Similarly, it's up to EPA to regulate pesticides—not because they were made by recombinant-DNA, but because they may be too toxic for humans and animals.

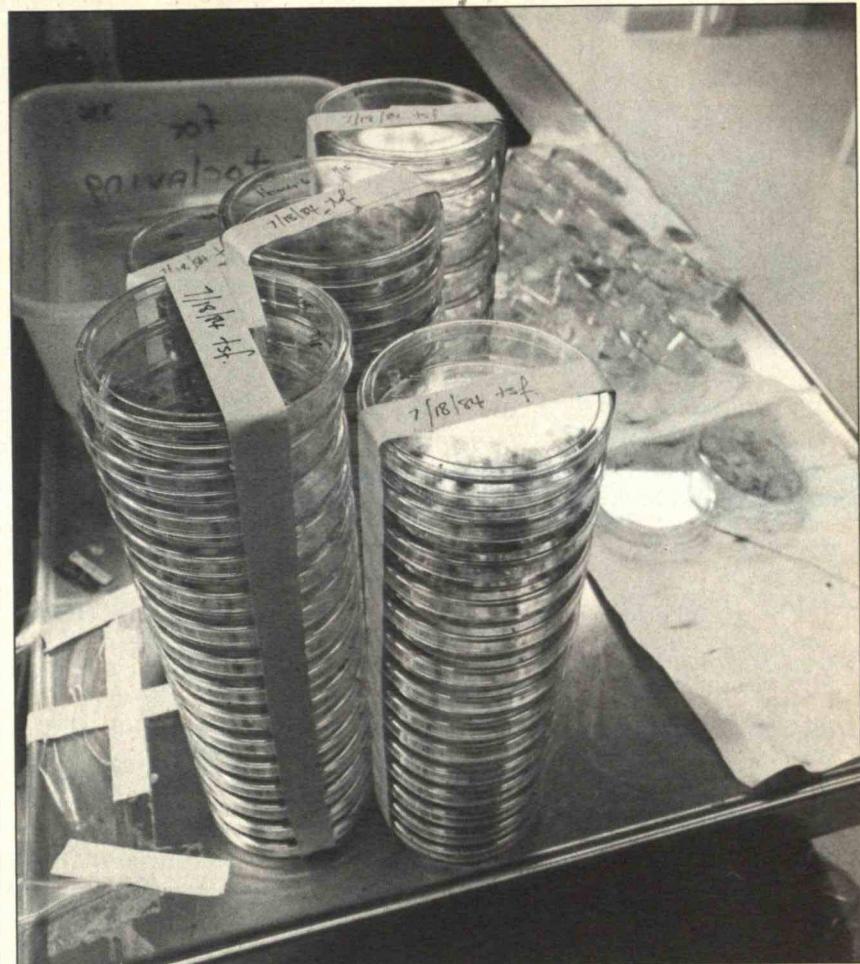
TR: Why do you think it's so important that RAC retain jurisdiction over the actual experiments?

BALTIMORE: When I was a member of RAC, the committee was a group of people who understood the technology, who pooled their expertise in a variety of areas to bring the highest form of professional judgment to bear. I would hate to be in a situation where technical decisions are made by people who don't have the necessary understanding. Recombinant-DNA technology is science at the cutting edge, and it is simply better understood and evaluated by scientists than by bureaucrats.

TR: Why can't EPA just bring in people who are knowledgeable?

BALTIMORE: EPA does not have a scientific arm that carries out its own research, and that's part of its problem. The FDA does a little better because they do carry out their own research, and there are some very good scientists there. So that might be a solution at the EPA. But I think there's another fundamental difference between RAC and EPA. When you move decisions into the EPA, you move them into the purview of people who are professional regulators. They may not be working in their own financial interests, but they're there to regulate and that gives them an axe to grind.

As all of us in universities are aware, administrators and administration will proliferate if you let them because administrators administrate. Well, regulators regulate. Proliferation of regulation is inevitable once you assign control of



something to a professional regulatory agency. RAC consisted of people who didn't consider regulation to be an important thing for its own sake.

TR: It sounds as if you want scientists to regulate science. Isn't that the same thing as asking nuclear engineers to regulate nuclear energy? What you're essentially proposing is a meritocracy—a world where decisions are made by experts—as opposed to a democracy where elected officials appoint bureaucrats to make decisions.

BALTIMORE: Now wait a second. NIH is led by appointed officials just the way EPA is. And RAC acted as advisor to the director of NIH through the director of the National Institute of Allergic and Infectious Diseases (NIAID). Both officials were appointed, and they made the final decisions on recombinant-DNA research.

TR: But they just followed RAC's advice, didn't they?

Molecular biologists routinely use *E. coli* bacteria as "factories" to clone interesting genes or manufacture valuable proteins such as insulin. Genes that code for these proteins are combined with plasmids, special strands of DNA that the bacteria will accept, and the entire package is then inserted into the bacteria. The altered bacteria can be grown in petri dishes (shown here) or in bioreactors for large-scale commercial use.



Proliferation of regulation is inevitable once you assign control of something to a professional regulatory agency.

BALTIMORE: Not all the time. There were a number of times when the director of NIH sent back a vote he thought was skewed and asked us to reconsider. And we did. In fact, because we knew that we had to satisfy the director of NIH, we made every effort to look at every angle and take into consideration every piece of public advice. As far as I'm concerned, the RAC hearings were a much more open process than a group of bureaucrats sitting around and talking to one another.

Furthermore, RAC was not limited to scientists; it had members of environmental groups, ethicists, philosophers. We had to convince these people that our arguments were valid. When I made an argument to RAC, it had to be very carefully thought through. Because I tend to think on my feet, I often will say something that isn't totally thought through. Every time I did that, there was somebody there to ask a question that required my considering it from another point of view. You didn't get away with anything on RAC.

TR: But RAC didn't have any teeth, any enforcement powers.

BALTIMORE: It may not have had any teeth, but it was respected and people have followed RAC a hell of a lot better than they followed EPA. Nobody ever did to RAC what Advanced Genetics Systems did to EPA. I really think it's a mistake to focus on whether a group is voluntary or not. If a group is respected, people will act accordingly.

I'm not suggesting that we set up an elite group of scientist-philosophers to design the world in the interests of the public. RAC fits into the framework of a democratic government, and there is no evidence that scientists actually control it. In fact, with the Berg letter, scientists were the ones who opened these decisions up to the public. Ultimately the public had it in their hands to close down the whole operation and they didn't. Take the city of Cambridge as a microcosm. They were prepared to close down

all recombinant-DNA work and they set up a panel of citizens who talked to everyone involved and ultimately recommended going forward under the NIH guidelines.

TR: But people are still having second thoughts. Aside from the issue of environmental release, some critics are saying that the scientific community is rushing pell mell into human gene therapy without considering the enormous ramifications of such treatment. Do you agree?

BALTIMORE: The scientific community has been intensively discussing the ramifications of human gene therapy for five years at a minimum, and I can remember discussions going back to the 1960s. The community has thought about this issue for years. I myself spent an inordinate amount of time talking with people about it. The public debate is in the newspapers every week in one form or another. In 1982, a presidential commission studied the issue in depth. The group wrote a report that drew a strong line between "somatic-cell" therapy, which involves implanting a normal gene into the body cells of a patient with a serious disorder, and "germline" therapy, which involves inserting a new gene into the reproductive cells that are passed onto future generations. No one is presently considering doing germline therapy. The presidential commission said that we should go ahead with somatic therapy as long as we know the treatment is effective and the patient has a serious disorder.

Since then, RAC has published guidelines on how the first somatic-gene therapy should be handled. There are still technical difficulties to work out, and I don't think we're going to see attempts at human gene therapy for a year or more. It seems to me that we have developed this new capability in a very deliberate manner. When media people or government officials think something is happening very fast, I think it is often because they are not aware of the extent of the preceding debate. □



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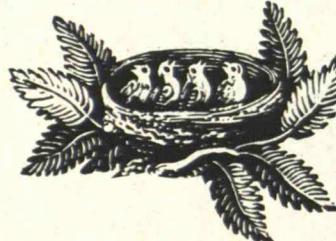
THE SUBJECT IS EXCELLENCE

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*Designing cities
to attract desirable birds
and animals makes aesthetic
and economic sense.*

Bringing Wildlife Back to Cities

BY ROBERT S. DORNEY



interesting behavior, and tendency to prey on unwanted species such as rats and pigeons. Such desirable wildlife can also improve the economic worth of the areas in which they settle. A recent study in Ontario showed that a housing development designed to fit into the natural landscape and attract certain kinds of wildlife actually brought its developer higher profits than a comparable development designed with no thought to natural landscaping.

Given these aesthetic and economic benefits, developers and city planners should design their projects to attract desirable and possibly endangered forms of wildlife to the city. At the same time, renovations and new construction should be designed to deter undesirable species such as pigeons, starlings, and rats. To achieve these goals, developers, landscape architects,

ROBERT S. DORNEY is professor of planning in the School of Urban and Regional Planning at the University of Waterloo, Ontario, Canada. He is also a director of Ecoplans Ltd., an environmental consulting firm in Waterloo.

PEREGRINE falcons circling overhead in downtown Boston, wild dogs roaming the streets of the Bronx in small packs of twos or threes, coyotes raiding garbage in suburban L.A. and eating pets—these are stories that grab headlines and evoke fear and fascination in the hearts of many urban dwellers. But such episodes are only part of a larger, far more interesting story: the growing presence of wildlife in our cities, and the expanding realization that cities can be consciously designed to encourage desirable species of wildlife to live there. After all, why should the urban environment be perceived as a place to escape from, a towering brick and concrete edifice hostile to nature?

Some animals, of course, will always be unwelcome in the urban environment. Rats, pigeons, and cockroaches have flourished amid the garbage and debris of city life for centuries, bringing with them disease and unpleasant associations. Some of the newcomers to urban life are equally unwelcome; no one particularly enjoys the sight of coyotes and stray dogs foraging for food in suburban and urban habitats. These animals also introduce the threat of rabies and bite injuries, particularly to young children.

As urban development continues to devour rural habitats in the United States and Canada, however, other animals are beginning to make their homes in the complex urban ecosystem. And many of these animals offer a pleasing dimension to life in the big city. Urbanites know that spring has arrived when they hear cardinals whistling in the ash trees that line their streets or tower over their backyards.

Many people also find pleasure in the wild ducks that increasingly make their homes in public parks and in the hawks and owls that have begun to roost in a few city parks. Such animals do not threaten the human population and, in fact, are admired for their attractive appearance,

civil engineers, naturalists, and city planners must work closely with wildlife biologists and ecologists. Through deliberate planning and design, cities can become places where people and wildlife comingle in harmony.

"Sloughs of Despond"

One would think that our European ancestors would have automatically built an awareness of nature into the design of Western civilization's first cities and towns. But as history and artifacts reveal, early cities were built according to a rigid format to defend the populace from military threat and to capitalize on the economic benefits of trade. European cities certainly did not originate as places of luxury and leisure. Indeed, the wealthy feudal lords of the Middle Ages lived outside the cities on their country manors; only the poor and burgeoning middle class lived in town. As European cities grew rapidly without planning or design, they became known as places of filth and disease. City dwellers simply hurled their garbage onto the streets, which were already littered with the manure of domestic horses and cattle. Rats and disease ran rampant.

Jonathan Swift captured the unsavory image of the city in an eighteenth-century poem in which he describes the results of a London rainstorm:

*Sweepings from the butchers' stalls,
dung, guts blood.*

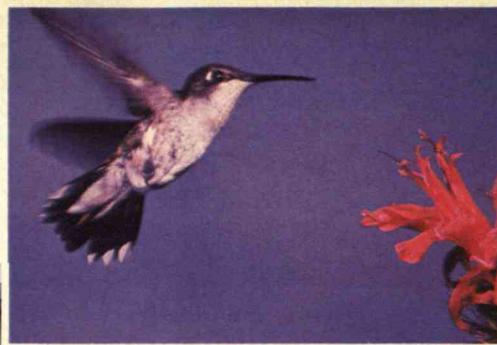
*Drowned puppies, stinking sprats, all
drenched in mud,*

*Dead cats, and turnip tops, come tum-
bling down the flood.*

Over the centuries, other writers and poets have only reinforced that image. Boccaccio, an Italian Renaissance author, wrote in the *De Cameron* of ladies and gentlemen escaping to a pastoral Shangrila far from the cities' plague and stench.



Much to the delight of urban dwellers, red-tailed hawks have begun to roost in city parks. Here a red-tailed hawk swoops down on a squirrel in Los Angeles.



To help save peregrine falcons from extinction, ecologists have deliberately released them into many North American cities. The tops of skyscrapers resemble the peregrines' traditional home: the rocky cliff ledges of North America. Left: Two peregrines nest on a roof in New York City. Top: The hummingbird prefers an urban or suburban backyard, where it can feed on the nectar of red-flowered plants.



where they could idle away the time with music and story.

Indeed, until the twentieth century our cities were "sloughs of despond," in John Bunyan's words, and some still are. But today, more than ever before, the leading cities of the world are culturally dynamic and revitalized hubs of activity that attract increasing numbers of people as residents, workers, and tourists. At least 80 percent of all North Americans live in suburban or urban environments, and even many of those who live in the country rely on the city for economic and cultural sustenance.

As a result, the quality of life in cities has become increasingly important, and they are no longer perceived as places to escape from. At the same time, many species of wildlife, their natural habitats under pressure from suburban development,

have begun to adapt to life in the city or on its fringe. For both these reasons, urban wildlife and its effect on city life have begun to attract the attention of biologists and ecologists. In the past 15 years, in fact, a new discipline called urban ecology has been created, and an increasing number of biologists, landscape architects, foresters, and biogeographers have discovered that urban wildlife is a topic worthy of study.

The Urban Ecosystem

It is surprising how much green area there is in a typical city. In Waterloo, Ontario, one of the few cities in the world whose biological surface has been mapped, 35 percent of the city's area is in active agricultural use, 9 percent is growing weeds as abandoned agricultural land, 25 per-

cent is in suburban grass and trees, 13 percent is in natural forest, and 3 percent is in city parks. Thus, about 85 percent of Waterloo is "green," with agriculture an unexpectedly strong land use in the outlying area just inside the city boundary. These statistics seem fairly typical for North American cities with populations of around 70,000. Many larger cities also have suburban areas and agricultural fields, giving them a similarly high percentage of green areas.

Even some cities in countries known for high urban densities have extensive green areas. Satellite photos show that Japan's Chiba City, with a population of 800,000 and lying on the east side of Tokyo Bay, has 22 percent of its area in forest land, 52 percent in agricultural land, 3 percent in marshland, and only 23 percent in ac-



The urban ecosystem often affects wildlife in unprecedented ways.

tual buildings. Thus there is precedent for even large cities retaining the 100- to 250-acre blocks required to sustain the high complement of woodland birds typically found in rural areas.

To better understand the urban ecosystem, my colleagues and I at the University of Waterloo have divided it into three mappable areas. The core is the built-up city zone that contains residential high-rises, offices, and industrial buildings as well as lower-density suburban housing. Lying outside this core but often still within the city boundary is the urban fringe zone, which contains rural land slated for development. Beyond that is the urban shadow zone, the outer area of the urban complex that workers commute to and from daily.

Although essentially rural with small towns and villages, this third zone contains commercial farms as well as "hobby" farms, gravel pits, waste dumps, scenic river valleys, and airports. In essence, it is a mix of the old rural landscape with the new suburban "station-wagon set." In large metropolitan areas, the core city may be completely built up, with the urban fringe and urban shadow located around nearby satellite cities.

These three urban zones provide a range of opportunities for different wildlife species. In the urban fringe woodchucks and seed-eating bird species flourish in agricultural fields and hedgerows—much to the dismay of serious farmers. In the abandoned fields that ring both the urban fringe and shadow zones, pheasants, woodchucks, field mice, rabbits, raccoons, possums, chipmunks, and deer can be found. Since hawks and owls feed on field mice and cottontail rabbits, they can also be found in these zones. Many bird species, generally between 15 and 25 different types, frequent suburban areas with older trees, flowers, and grass.

In the city zone itself reside such traditionally undesirable species as rats, pigeons, English sparrows, and starlings. Like pigeons, starlings and English sparrows are largely considered pests: they befoul buildings and grounds, and noisily congregate on winter roosts. Most urban dwellers are also not particularly happy about such johnny-come-latelys as raccoons, "wild" dogs, and coyotes.

Raccoons actually pose a serious health threat in the United States by bringing rabies into cities. Although rabid raccoons do not usually bite people, they do trans-

mit the disease to pet dogs who roam the same urban and suburban terrain. Dogs, in turn, transmit rabies to humans, particularly young children.

Three types of dog populations now live in a typical city: dogs owned by residents, dogs who are abandoned and become strays, and feral dogs who are the offspring of strays. Contrary to popular belief, pet dogs are the canines most likely to attack and bite young children. They are less afraid of humans than stray or wild dogs and more likely to defend their perceived territories.

Stray dogs usually find shelter in areas of high human density—in abandoned cars and even in the hallways and common areas of occupied buildings. Feral or wild dogs are more common in areas of low human occupancy, such as the decaying sections of larger cities where there is food, cover, and little effort to control animals. Alan Beck of the University of Pennsylvania has reported packs of wild dogs roaming the streets of St. Louis and deserted areas of Baltimore. Both stray and wild dogs feed on the dumps and trash cans that proliferate in urban areas, fouling sidewalks and killing trees and plants with their digging and urine.

By contrast, many urbanites are enthralled by such newcomers as the owls and hawks that spend their winters in public parks, and by the peregrine falcons that now breed and nest successfully in cities such as Boston, Baltimore, Calgary, Edmonton, Montreal, and Toronto. Ecologists have deliberately released peregrine falcons, an endangered species, into many North American cities to save the birds from extinction. The tops of modern skyscrapers turn out to be a rough facsimile of peregrines' traditional home: the rocky cliff ledges of North America. These birds also serve a very useful function: they feed on starlings and pigeons.

In contrast, the red-tailed hawk has made its own way into downtown Boston, attracted by the plentiful supply of squirrels and rodents in the Boston Common and Public Garden. Some hawks now spend the winter in Boston, migrating north when spring finally arrives. Owls have also been observed in Boston-area parks in the fall and winter.

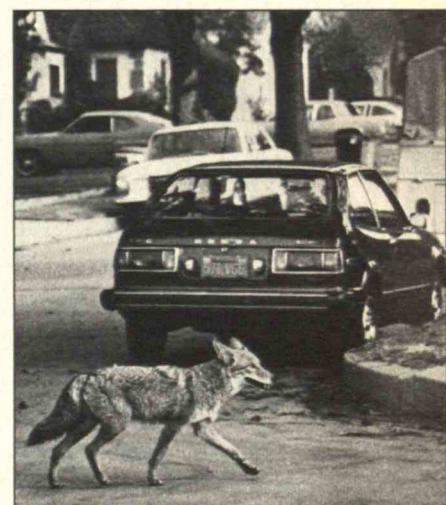
Certain kinds of wildlife move among all three urban zones, tying them together into a complex, interdependent ecosystem. For instance, in the fall, hundreds of starlings roost downtown at night but fly

many miles into the urban shadow to feed on waste grain from commercial farms. Mallards and Canada geese loafing in urban ponds by day will make early morning and late afternoon flights to feed on the same waste grain.

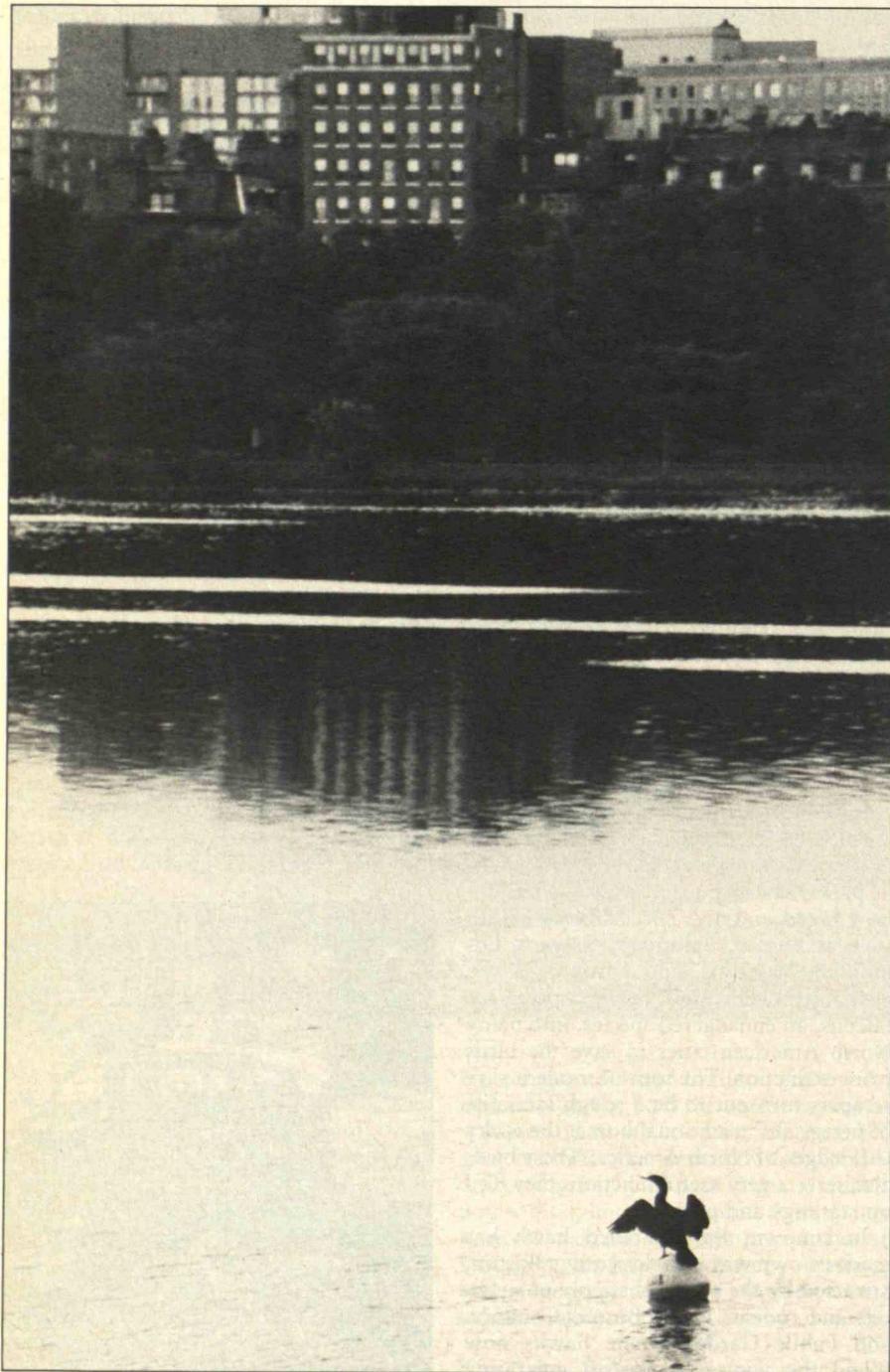
The Gull-Hatching Index

The urban ecosystem often affects wildlife in unprecedented ways. For example, in most major cities afternoon air rises over the downtown area as the mass of buildings warms the area. Such heat islands carry insects up over the city from adjacent parkland, providing food for the nighthawks and chimney swifts that career back and forth over the urban center. The nighthawks used to build their nests and roosting habitats in flat prairie areas, and the chimney swifts nested in the hollow trees of forests. But as forest and prairie land disappeared and the birds found insects available in cities, these birds began to nest on the flat roofs of buildings and in abandoned chimneys. These two attractive species are now more common in North American cities than in rural areas.

Similarly, in Tucson, Ariz., urban development of desert areas—with the resulting increase in weeds and grassy areas as residents create lawns—has attracted Inca doves and other unusual bird species



Fed by residents, coyotes have become a nuisance in Los Angeles County, sometimes eating pets. Coyotes usually do not bother humans, but a few years ago one killed a girl who had been feeding him for several months.



Many cities are home to pets that either escaped from captivity or were set loose. For years, departing college students dumped goldfish into the Charles River in Boston. Now that the

Chales has been cleaned up, the goldfish thrive, and cormorants (above) have discovered them. Stray dogs also roam the streets of many cities, particularly in decaying areas (opposite).

But like wild urban dogs, they are unlikely to attack. Pet dogs are actually more dangerous because they are less afraid of humans and more likely to defend their perceived territories.

from the surrounding desert.

In the urban shadow zone, landfills increasingly provide a steady food supply for gulls. The gulls commonly nest on islands at sea or on those created by dredging and filling harbors. These gulls fly dozens of kilometers daily to feed on outlying landfills, and their populations have increased substantially with the rise of cities. If nothing else, the "gull-hatching index" or GHI might be a valuable indicator of economic activity for the gullible economist.

Many cities are also home to species that have either escaped from captivity or were deliberately released into the urban environment—not always with desirable results. Perhaps the best known example of this was the release of starlings in New York's Central Park in 1890 by sentimental literary buffs trying to establish European birds mentioned by Shakespeare. Although the nightingale, released at the same time, did not survive, the starlings have become one of our more successful urban birds, and a distinct nuisance.

More recently the Monk's parakeet and canary-winged parakeet, imported as pets from South America in the 1960s, have become successful colonists in Miami and Tampa. Hundreds of these exotic fruit-eating birds have invaded rural areas in southern Florida, damaging mango, avocado, and orange groves. Citrus growers have been forced to bring in trappers to capture these birds and give them back to pet stores. In Boston, schools of goldfish are making their home in the increasingly clean waters of the Charles River. Dumped there by departing college students, the goldfish have recently been discovered by cormorants, sea birds that are also showing up in growing numbers around the Charles River basin.

Saving Animals While Saving Money

The aesthetic reasons for attracting wildlife to the city are obvious. Most people would also consider attempts to help endangered species adapt to urban life a worthy social goal. Nonetheless, many urban developers, politicians, and planners view efforts to design with nature in mind as a "frill," and they are hesitant to include such details in their plans for new projects. After all, custom landscape designs and environmental consultants only raise the cost of a project, and developers often say they have no evidence that these extra costs will be offset by higher profits down



Unfortunately, many developers view designing with nature in mind as a "frill."

the road. Solid evidence of economic benefits from large-scale urban projects does remain scarce. However, my colleagues and I have found that natural landscaping and design can increase the overall value of suburban housing developments.

In the 1960s, the city of Waterloo, Ontario, approved two mixed-density private housing developments, each about 450 acres in size. In the development known as Beechwood, a civil engineer and a landscape architect worked together to incorporate natural valleys and upland woodlots into the area's overall design. The developers laid out lots, roads, driveways, and service lines so as to retain the wooded areas and preserve the trees in each home's backyard.

The developers of the other parcel, known as Lakeshore Village, made no effort to save trees throughout the lots, nor did they seek professional landscape, architectural, or environmental advice. Instead, they preserved one large wetland forest as public parkland to meet the city's minimum requirements for open space. The stream that ran behind some lots was converted into a straight engineered ditch for storm drainage.

Because the Beechwood development retained natural wooded areas, bird populations remained diverse and plentiful. We counted 31 different species of birds, including kingfishers, mallards, cardinals, and chipping sparrows, in a single area of the development. We found that this bird population has as high a diversity as nearby rural woodlots but almost three times the density. The shrubs, lawns, and bird feeders that have replaced cornfields and pastures presumably provide better nesting and wintering habitat for many species.

In Lakeshore Village, by contrast, both the number of birds and their diversity have plummeted since the development was built. We counted only 12 to 18 different bird species, and found that many of the native populations had been replaced by starlings and English sparrows—not exactly the most popular birds.

More important from a developer's point of view was the marked difference in profits that resulted from the two projects. The costs per acre for Beechwood were \$18,687; those for Lakeshore, \$17,625. Moreover, the net profit per acre for Beechwood was \$15,945; that for Lakewood, \$10,295. Although the Beechwood developers experienced higher up-

front costs because of their careful landscape design, higher charges for routing utility lines and construction of a community recreation center, their profits were one-third higher in the end because homeowners clearly preferred Beechwood over Lakeshore Village. The Beechwood housing development is one example of how builders can profit from designing open space and preserving trees around homes to attract desirable species. Studies have also shown that lots with trees preserved in natural arrangements have a higher market value than those without trees.

Homeowners and developers can use other strategies to attract wildlife as well. Many bird species prefer specific types of plants for nesting and feeding. Hummingbirds like red flowered plants that provide them with nectar; song sparrows require at least a tenth of an acre of shrubs, trees and lawns to nest successfully. Butterfly bush, also called by its Latin name *Buddleia*, can attract swallowtail butterflies to feed. Milkweeds, including butterfly weed, attract monarch butterflies. Wood nesting

boxes hung in quiet treed areas can attract house wrens.

Some forms of urban architectural design inadvertently discourage desirable forms of animals, particularly birds. For instance, migrating birds often see the reflecting windows on skyscrapers as sky and fly into the glass, killing themselves. Installing venetian blinds in those windows is a good way to warn the birds about the glass. Bright floodlights on towers that confuse migrating birds and bring about their death through collision and exhaustion can be dimmed after 10 p.m. to reduce such losses.

Designers can also minimize habitats used by undesirable animals while renovating and constructing buildings. For instance, developers building highrises should avoid installing cornices and deep window sills, which attract pigeons. In older historic buildings where niches cannot be removed, wire protection, removal of nests, or the use of chemical repellants may be required.

Signs placed flush with building surfaces can discourage the presence of English





sparrows in winter, since signs placed slightly off buildings offer the birds warm shelter. Open overhangs and laundry vents can also be ideal places for starlings to nest. Closing these overhangs by adding soffits to box in the eaves, requiring that all new buildings have boxed-in eaves, and covering vents with screen can help reduce starlings' breeding sites.

Planners can also control undesirable species by designing habitats that encourage desirable animals to compete for the same food supply. For example, urban landscape architects could plant blocks of oaks, hickories, and red maples in parks and on institutional sites to attract gray squirrels. Since squirrels scavenge food scraps, high squirrel populations should put a brake on rat populations wherever the two species overlap, such as in schoolyards, zoos, and park pavilions.

In most cities, animal rescue squads attempt to keep down the number of stray or wild dogs by capturing and eventually killing them. However, the people who have the most effective long-term control over the urban stray population are the dog owners of the city. Wild or stray dogs do not reproduce well in an urban environment—their mortality rate is simply too high. Instead, their numbers are continually fed by abandoned or runaway pets. If urban pet owners were more conscientious about supervising their dogs, the stray population now found in some cities would eventually disappear.

Considering Wildlife in the Design Process

The ecological information for this type of careful planning is already available, amassed over the last two decades by biologists and ecologists who specialize in urban wildlife. However, it is not always accessible to the developers, landscape architects, city planners, and civil engineers who make the important decisions about urban design. Many of the engineering firms in the United States and Canada continue to do urban landscaping without the benefit of advice from wildlife specialists, and it is rare to find city planners who have expertise in wildlife ecology.

There are a number of solutions to this problem. First, architecture and engineering schools must do a better job of teaching their students about the biological dynamics of landscape and the monetary advantages of planning for urban wildlife.

City planners can control undesirable species by bringing in animals that compete for the same food supply.

Second, city planners and engineering firms must seek out the advice of wildlife biologists on urban projects. About 5,000 full- and part-time environmental consultants now practice in North America. Although these people spend most of their time assessing the environmental impacts of roads, power plants, and waste-management plants, they could apply these skills to urban environmental design. Many small consulting firms can combine advice on managing soil erosion, woodlots, urban wildlife, and water quality.

Third, computer models could be used to identify the specific components of a habitat—the type of plants and size of plantings—required to attract different wildlife species. These models could then be made accessible to working landscape architects and engineers. Urban designers already use similar models for managing traffic, noise, trees, and surface water. A wildlife model would simply add to the designer's tools by predicting the wildlife that would inhabit various land-use configurations.

A few cities now require developers to include wildlife studies in their environmental reports before approving subdivisions and allowing builders to convert rural land to urban. For instance, Mississauga, Ontario, a wealthy suburb of Toronto, requires all developers to submit a plan detailing the size and scope of wooded areas to be preserved in a new development. The plan must also outline the type of vegetation planned for individual lots and open spaces. Municipal officials must approve this plan before the developers can even submit the overall subdivision plan. Municipalities throughout the United States and Canada would

do well to emulate this type of approval process if they want to preserve existing wildlife and enhance the aesthetic value of their communities.

Some municipal officials have already recognized the value of preserving natural urban areas as part of large-scale revitalization projects. In Ontario, for instance, local officials have reclaimed waterfront parkland along Lake Ontario by creating small grassy areas along the shore with excavated fill. Local residents use these jutting mini-parks, lined with stone to prevent erosion, to launch small boats, fish, swim, and otherwise enjoy the ducks, geese, and other forms of wildlife that have flocked to these areas.

Urbanites interested in attracting wildlife to their backyards, porches, and terraces can consult a number of organizations for advice. The National Wildlife Federation in Washington, D.C., provides a kit that includes information on plants attractive to wildlife, blueprints for birdfeeders and birdhouses, and beneficial designs for backyard pools, among other features. More books on natural gardening, which incorporates native trees, shrubs, and herbs in natural assemblages into front and backyard areas, are being published each year. Natural gardening techniques shelter the house and thus save energy costs, reduce maintenance costs, enhance privacy, and encourage wildlife, improving the aesthetic environment. More and more homeowners in North America are beginning to realize that landscaping for small urban lots (one-fifth of an acre or so) can have a naturalistic as well as a decorative focus.

Designing with nature in mind, as opposed to just bulldozing it, favors property owners, other urban dwellers, and developers alike. If nuisance species can be controlled through architectural design, and special plantings and nesting structures can be created in parks and backyard gardens, a better fit between humans and nature is certainly achievable in our cities. □

FURTHER READING

- Dorney, R.S., "Urban Wildlife Populations: A Look at Downtown, Uptown, and Suburban Residents." Smithsonian Institution Symposium Proceedings—Wildlife Survivors in the Human Niche, Washington, D.C.: forthcoming.
- Hough, M., *City Form and Natural Process*. New York: Van Nostrand Reinhold Co., 1984.
- Spirn, A.W., *The Granite Garden: Urban Nature and Human Design*. New York: Basic Books, 1984.

You are reading perhaps the most successful corporate advertising campaign ever, Science/Scope, which marked its 20th anniversary in September 1986. The campaign—distinguished by its editorial style of writing, newsletter format, and yellow background color—was created in September 1966 to inform readers of advances in technologies and programs at Hughes Aircraft Company. It has won scores of awards for creative excellence and for leading readership surveys in a variety of publications. The first ad reported on such technological advances as a technique for keeping a satellite stable in orbit, an infrared-guided missile, and a spacecraft instrument that could categorize the surfaces of planets. Today Science/Scope appears in approximately 80 publications worldwide and 10 languages. We thank our readers for their continued support.

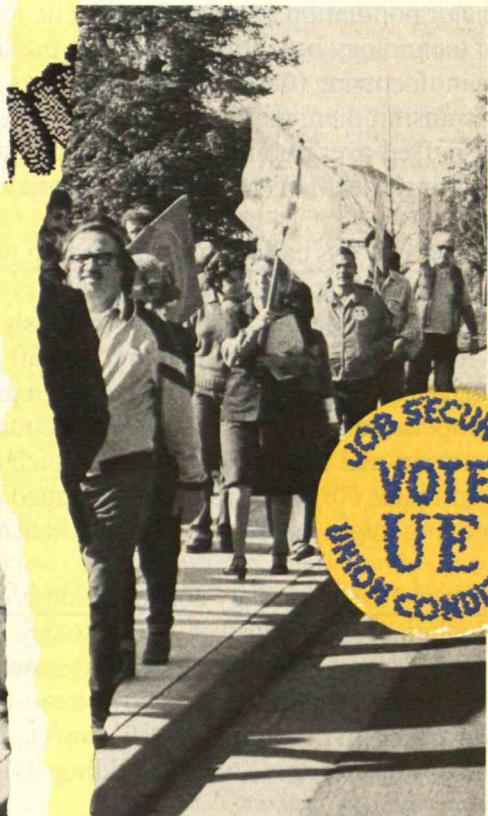
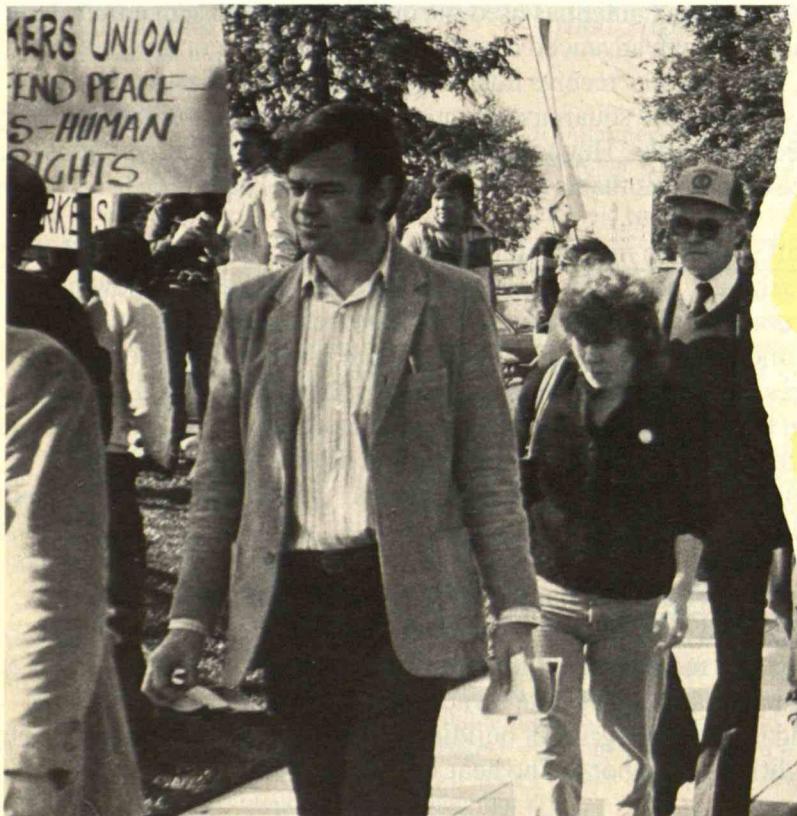
Four sophisticated antennas will let Intelsat VI communications satellites concentrate signals on four major population areas on Earth. The four squareax antennas used in combination represent a multitude of technology breakthroughs made possible through advanced computer-aided design/computer-aided manufacturing (CAD/CAM) techniques. The antennas receive microwave signals from Earth and retransmit them with pinpoint precision. Without the squareax antennas, those signals would be uselessly dispersed over populated and unpopulated areas alike. Hughes designed and built the antennas and is heading a team of international aerospace companies that is building the Intelsat VI satellites.

A new process called vacuum brazing will soon help manufacture advanced radar components for U.S. fighter aircraft. Vacuum brazing forms extremely strong joints between lightweight metals, allowing engineers to design parts that previously could not be manufactured. The process involves treating parts with a special brazing alloy and a small amount of magnesium. The parts are placed inside the vacuum furnace, which normally operates at a pressure of one millionth of an atmosphere, and heated to temperatures of 1100°F. Because vacuum brazing requires no flux, it is far more economical than conventional flux dip brazing, in which components are dipped into molten salts. The process also eliminates corrosion caused by trapped or residual flux. Hughes engineers are investigating how vacuum brazing might be used to fabricate heat dissipators and other radar parts.

Helping to trim energy consumption is one major use of a hand-held infrared viewer. The device is a Hughes Probeye® viewer, which senses heat and displays images through an eyepiece. Mining officials use the device to inspect electrical systems and mechanical equipment because it detects potentially dangerous short circuits and overheating hardware. Real estate owners, developers, and appraisers use the viewer to determine the structural and thermal integrity of buildings. The unit reveals moisture spots in roofing and spots where buildings might be gaining or losing heat.

Hughes is seeking experienced engineers and scientists to further develop advanced spacecraft systems and components for communications satellites. Openings are in the fields of: software, computers, and data processing systems; electrical components; microwave/RF communication systems development; on-board spacecraft electronics and control systems; satellite design, integration, propulsion, and electrical power system development; spacecraft manufacturing, systems test and evaluation; GaAs applications R&D. Send your resume to Dan Frownfelter, Hughes Space & Communications Group, Dept. S2, S4/A300, P.O. Box 92919, Los Angeles, CA 90009. Equal opportunity employer. U.S. citizenship required.

For more information write to: P.O. Box 45068, Los Angeles, CA 90045-0068



The National Labor Relations Act gives all employees these rights:

- To organize themselves;
- To form, join or help unions;
- To bargain as a group through a representative they choose;
- To act together for collective bargaining or other mutual aid or protection;
- To refuse to do any or all of these things.

Do Unions Have a Future in High Technology?

Contrary to popular wisdom, the life of high-tech production workers isn't rosy. Unions could help, but innovative strategies are needed to surmount formidable barriers to organizing.

BY STEVE EARLY AND RAND WILSON

ONE morning last winter an author of this article was distributing union literature outside a Lawrence, Mass., semiconductor plant. As the workers trudged through the gate, most accepted the handbills without comment. An exception was one middle-aged woman who walked on a few steps before looking at hers. Realizing what it was, she turned and, with genuine surprise, asked, "You mean there are still unions?"

It's a question that reveals much about how organized labor is viewed today by many of the 2.5 million unorganized production workers at electronics companies around the country. Working for any of these firms—Digital, Wang, Texas Instruments, National Semiconductor, or the grandfather of them all, IBM—one could easily get the idea that unions, like dinosaurs, have completely disappeared.

In 1983, several unions surveyed more than 300 Massachusetts high-tech workers. The results confirm that organized labor is not well regarded. Among the production workers, 48 percent expressed a "low opinion" of unions, including 19 percent who had a "very low opinion." An even larger number—67 percent—did not believe they would be better off if they belonged to a union, while



just 28 percent felt that they would be. Only 32 percent had a "high opinion" of unions and only 5 percent, a "very high opinion." A mere 25 percent said they would vote for a union.

On the other hand, 40 percent of those polled were dissatisfied with their opportunities for advancement, and the same proportion didn't like the way their employer decided pay raises. About a third were unhappy about issues such as access to training programs, the discrepancy between wage increases and company profits, and women's chances of improving their status.

The lengthy and well-publicized sales slump in computers and electronic components has magnified the job-related problems of the largely unrepresented production, clerical, and technical workers who make up over 65 percent of high-tech employment. In 1985 alone, tens of thousands lost their jobs in the Silicon Valley area of California's Santa Clara County and on Massachusetts' "Technology Highway," Route 128.

Layoffs were only the most visible symbol of widespread hard times. A survey by the High Tech Research Group in Massachusetts shows that during that same year Wang Laboratories and Data General each furloughed 6,000 workers for several weeks. LTX workers faced three separate furloughs of a week each, and in May the company cut pay by 7.5 percent. Hewlett-Packard furloughed workers for two days per month—the equivalent of a 9 percent pay cut.

High-Tech Myths versus Reality

According to management, unionization remains unpopular among high-tech workers because they enjoy generous benefits, flexible work schedules, attractive workplaces, and competitive wages. The media reinforce this idea with reports about workers finding fulfillment in a Digital quality circle, spending lunch hours in a hot tub at Rolm, or golfing at the Wang Country Club.

However, while salaries, benefits, and personnel practices are favorable for some highly skilled technical and professional employees, most production



workers face a different reality. For example, the average hourly wages in semiconductor production are only 57 percent of those paid in unionized steel or auto production.

Without unions, all high-tech wages, hours, working conditions, and personnel practices are established unilaterally by management, rather than through negotiation between workers and management. Employees have no contractually guaranteed rights, and their length of service can be disregarded in promotions, layoffs, and recalls. Speaking of its 1985 layoffs, Data General's director of corporate affairs said, "Seniority was considered, [but] it was not an overriding factor." Wang's senior public-relations specialist said, "Seniority was not a major factor. . . . Layoff decisions were based solely on the needs of the business as ascertained by management." Neither company had a policy of giving laid-off workers with seniority preference in re-hiring.

Although many companies such as IBM, Digital, Control Data, and Texas Instruments have instituted grievance procedures, almost none include provisions under which a neutral third party can decide cases. Worker representation in the grievance process is similarly lacking. Final authority rests with management. Experienced workers in non-union plants often refer to these "open door" procedures as "out-the-door" procedures—a means to eliminate those who try to use them.

Control Data instituted such a procedure over 20 years ago. As with most of the plans that followed at other companies, employees initiated a grievance by talking to their immediate supervisors. Then, if

STEVE EARLY is a lawyer and labor journalist employed as a union staff member. RAND WILSON is a former high-tech worker and organizer. He is currently East Coast coordinator of Integrated Circuit, the National High Tech Network.

Employees of Telelogic didn't know they were laid off until they found that their computer access codes no longer worked.

they were still dissatisfied, they went to the personnel department, and so on up the management chain. Writing in the *Harvard Business Review* in 1984, Fred Olson, Control Data's director of work-problems counseling, admitted the program emphasized process over results. Middle managers rarely overruled those below them, and many grievances were never resolved at all. When they were, they often had to reach very high-level managers, who had little direct knowledge of the issue. Olson observed that few rulings were in favor of the worker. (As a result of these shortcomings and the lack of employee confidence in the procedure, Control Data recently revised its system to include a grievance review committee with worker representation.)

Electronics-industry production workers have difficulty advancing to more highly skilled jobs because company training and tuition-reimbursement programs generally require that any outside study enhance the position currently held or at least relate to it. This tends to disqualify most unskilled and semi-skilled workers. For example, at ATEX in Bedford, Mass., according to a 1981 memo on qualifying for tuition reimbursement, a course must "a) relate to your present position with ATEX; b) relate to your career development at ATEX; or, c) be a required part of a program leading to a degree *if the degree is related to your present position or career at ATEX.*" In 1983, a *Wall Street Journal* report estimated that less than four percent of employees participate in such programs.

The lack of training opportunities and fair promotion systems reinforces the segregation of women and minorities in dead-end jobs. The vast majority of clerical and production operatives are women. In California over 50 percent of the production operatives are minorities, and a large percentage of the work force consists of immigrants.

The highly skilled jobs with good pay go to men. According to a study by Patricia Madson, research director of the Center for Massachusetts Data at the University of Massachusetts in Amherst, women make up nearly 40 percent of the state's high-tech work force. Yet only 11 percent are managers or professionals, and only 1 percent are in sales. Madson also found that a woman in high tech earns only 55 cents for every dollar a man makes. Blacks hold only 3.6 percent of all jobs in the industry and are mostly confined to unskilled and semi-skilled positions.

At Hewlett-Packard, only 8.3 percent of all middle managers are minorities. According to the company's official publication *Measure*, only 47 minority employees—5.2 percent—have risen up to or above the level of functional managers. No blacks or Hispanics are general or operations managers. Most other companies are even reluctant to make such figures available.

High tech is often hailed as a clean industry that creates few health and safety problems for its workers or threats to the environment. In fact, high-tech production procedures are chemically intensive and often quite dangerous. Company health-and-safety records for 1980 through 1982 show that compared with other production workers, California semiconductor workers had three times the rate of occupational illness serious enough to cause lost time. Workers-compensation statistics for the same period show that semiconductor workers had twice the incidence of illness from exposure to toxic chemicals.

Perhaps the most misleading claim of many high-tech companies involves their so-called "no-layoff" policy. During its boom years, high tech gained a reputation for stable employment that made it attractive despite relatively low wages. But during the most recent sales slump, work forces have been reduced dramatically. Since January 1985, over 7,000 of the approximately 200,000 high-tech workers in Massachusetts have been permanently laid off. Another 15,000 have lost income because of furloughs or wage cuts, and thousands who left the industry voluntarily have not been replaced. In Santa Clara County, the number of electronics production workers declined from 215,300 in September 1984 to 199,500 in May 1986.

The 1985 layoffs indicate that job security in the electronics industry is as tenuous as in any other manufacturing industry. It was a painful lesson for many high-tech workers. Among 23 firms surveyed by the High Tech Research Group, none gave more than one day's notice of layoffs, although some did provide resume-writing services and severance pay. At Telelogic in Cambridge, Mass., employees did not learn they were laid off until they found that their computer access codes no longer worked. Soon afterward, Digital announced plans to reduce its work force by 5,000 over the next three to five years through attrition and other methods.

Even IBM is reconsidering its commitment to no layoffs. In June 1986, a *Boston Globe* article quoted

Quently 90 of the 1,900 companies in the American Electronics Association have union contracts.

Stephen Coen, a former IBM employee now analyzing the computer giant for the Gartner Group. He said that IBM often consolidates divisions and transfers people, expecting that many will resign rather than accept the new conditions. He further charged that the company downgrades employees into jobs where new performance standards can be used to terminate as many as necessary.

A growing number of high-tech companies such as IBM and Digital are able to maintain the appearance of not laying off workers during slow periods because they employ many temporary production workers. Long-time Silicon Valley labor organizer Mike Eisenscher contends that the entire industry is restructuring its work force to create a pool of such "temporary disposable workers." While no data exist on the exact number of temporary workers in high tech, Eisenscher notes that "Santa Clara County now has one of the largest concentrations of temporary work agencies in the nation as more and more companies turn to the employment of temps rather than permanent workers." According to the *Monthly Labor Review*, the number of temporary workers in all industries increased nationally by 70 percent between 1982 and 1984. These workers receive lower pay and fewer benefits than do regular employees.

How Unions Might Help

Unionized workers threatened by job reductions and related dislocations have far more protection than do workers in similar situations in non-union high-tech firms. For example, telephone workers who belong to the Communication Workers of America (CWA) have seen AT&T and its recently divested Bell operating companies eliminate thousands of jobs since 1982. In 1984 AT&T reduced employment by about 20,000, and the regional Bell operating companies collectively lowered their payrolls by 21,000. But aggressive bargaining by CWA has softened the impact of these reductions by providing severance pay and early retirement packages and by establishing mutually agreed upon layoff, recall, transfer, and retraining procedures.

Under these provisions, AT&T has been required to give union representatives 30 days' notice of layoffs, part-timing, and reclassifications, with a description of the locations, work groups, and title classifications involved. AT&T must also provide

the union with six months' notice of any technological change that will create a surplus in any job title. Workers with sufficient seniority whose jobs are de-skilled or downgraded due to the introduction of new technology retain their old rates of pay for an extended period of time. When layoffs do occur, temporary and occasional employees must be separated from the payroll first. After this, regular full-time and part-time employees are laid off, reclassified, or put on part-time schedules according to their length of service.

In the massive restructuring of telecommunications services created by divestiture, thousands of CWA members have opted for early retirement, voluntary separation from the company, or reassignment to new positions within the industry. CWA has negotiated a variety of plans that protect workers from income loss. Because of these provisions the union recently won a major arbitration award after AT&T unilaterally transferred 2,500 marketing workers into AT&T Information Systems, which would have resulted in a reduction in both benefits and negotiated contract rights. After failing to resolve the problems internally, the case went to a neutral arbitrator, who ruled that the adversely affected employees be fully compensated for "any losses sustained by the company's denial of their contractual rights."

Union representation thus offers more than job security. Union contracts also establish procedures for resolving disputes, first at joint union-management meetings, and if necessary by resorting to a neutral arbitrator who settles the case on the basis of the agreement between the union and the company. Union grievance procedures allow workers to monitor company policies and practices to ensure that management complies with contracts.

In spring 1986 contract negotiations with AT&T, CWA secured further improvement in employment security protections. The new CWA-AT&T agreement requires the company to produce an annual report identifying jobs that are likely to grow or decline, and to detail the skills required for each job category. The agreement creates a jointly owned and managed comprehensive training program to help union members who may be displaced prepare for future employment within AT&T subsidiaries or at other firms. The union also negotiated a new plan that guarantees workers the right to transfer to available jobs in other subsidiaries of the company and

1985 Cutbacks at Selected Massachusetts Firms	
Apollo	3,800 furloughed for 6 days in August, 7.5% pay cut for U.S. field sales group, 300 layoffs
Computervision	635 layoffs
Data General	6,000 furloughed for 1 week in July and September, 480 layoffs
Foxboro	715 take early retirement (incentives funded through pension plan), 390 layoffs
GCA	1,500 furloughed for 1 week in July, 730 layoffs
GenRad	1,500 furloughed for 1 week in October, November, and December; 584 layoffs
Hewlett-Packard	2 days off per month = 9% pay cut, 1,000 furloughed for 1 week in July
Honeywell	1,000 furloughed for 1 week in April, May, August, and December; 270 layoffs
LTX	7.5% pay cut in May; 1,200 furloughed for 1 week in May, July, and August; 500 layoffs
Varian Associates	648 layoffs
Wang	6,000 furloughed for 2 weeks in July, 1,000 layoffs

the right to be recalled from layoff before there is any hiring of new employees. The union also obtained a commitment from AT&T to refrain from subcontracting work when layoffs are pending or have taken place.

Barriers to Organizing

Despite the benefits of unionization, high-tech workers remain largely unorganized. The American Electronics Association (AEA) surveyed its nearly 1,900 member firms about union activity between 1971 and 1982. The results showed that during this period fewer than 100 National Labor Relations Board (NLRB) elections were held to determine whether unions should be recognized at specific plants. Unions won just 21. Moreover, the vast majority of employee organizing efforts never reached an NLRB election. Only 90 of AEA's 1,900 member companies have union contracts.

One reason so few high-tech workers join unions is that "union prevention" is built into the personnel practices of most high-tech firms. For example, employee-participation schemes are common. In small group meetings attended by supervisors and representatives of top management or the "human resource" department, employees are encouraged to discuss work-related problems. However, should employees raise fundamental issues—such as procedures for promotion or wage levels—they risk being eliminated from future meetings. They may even cause the group to be disbanded.

In some instances, group leaders use the discussions to identify pro-union workers or other "trou-

blemakers." John Cunningham, who has helped lead battles to improve job health and safety at National Semiconductor in California, won a seat on a company-controlled safety committee in 1980. After he and other workers took this assignment seriously, the company changed the committee into a quality circle. Then, when Cunningham insisted that the quality circle address the persistent safety violations, National Semiconductor excluded him from the group.

The organization of production in high tech tends to isolate and divide workers from one another. As Eisenscher notes, "Unlike auto factories, steel mills, and other basic manufacturing facilities, semiconductor and computer-manufacturing plants generally do not have large numbers of employees performing functions on an integrated line or manufacturing process." The work is done in small units, in departments with six to thirty workers. Jobs are compartmentalized and closely supervised, with a relatively high ratio of supervisors to workers. Plants tend to employ fewer than 500 workers, and products are manufactured in a cluster of several facilities that may be miles apart. Furthermore, many companies require some employees to work a standard eight-hour day five days a week, while others work four ten-hour days or three twelve-hour days. With staggered shifts, only a portion of the work force is in the plant at any one time.

Such arrangements and the use of temporary, part-time, and weekend-only workers make it difficult to forge the unity necessary for a successful unionization campaign. Owing to their job insecurity and the ever-present dangling carrot of promotion to permanent status, temporary workers are especially reluctant to engage in organizing activity.

The most effective deterrent by far, however, is outright repression of union activity. In Silicon Valley and elsewhere, high-tech managers have not hesitated to harass, fire, and blacklist union supporters to disrupt their organizing efforts.

An account of recruitment drives conducted by the United Electrical Workers Union (UE) between 1971 and 1984 in Santa Clara County provides many examples of this management response. In 1973, workers at Tomco voted 24 to 1 to affiliate with UE. Then two months after bargaining began on a contract, Tomco locked its employees out and later shut down its operations. In 1974, a majority of the 160 Siltec workers signed union cards, but the

Workers at Atari reacted to wage cuts and rumors of layoffs by visiting the nearest union they could find.

drive faltered after the company fired 15 key workers. In 1982 National Semiconductor fired Cunningham for circulating a petition supporting a worker who had been arbitrarily fired.

That same year, Signetics fired UE supporter Rachel Marshall. The 1984 National Labor Relations Board trial in Marshall's case revealed that management and a co-worker had framed her to build a case for the firing. The worker who aided the company disclosed this in testimony before the NLRB and was later fired herself. The NLRB ordered Signetics to reinstate Marshall with back pay.

The Marshall and Cunningham cases were the only two in which the NLRB held hearings on behalf of dismissed workers. The board found that National Semiconductor had violated the law when it fired Cunningham, but, because of a technicality, refused to order his reinstatement or a back-pay award.

Two Campaigns

One of the most illustrative and well-publicized high-tech organizing campaigns in the last decade involved workers in the division of Atari that produces coin-operated video games. In 1982 they reacted to wage cuts and rumors of layoffs by visiting the nearest union they could find: Local 1621 of the Glaziers, Architectural Metal, and Glass Workers Union.

Workers immediately began signing the authorization cards needed for a representation election. However, the Glaziers is a small union, and Local 1621 had little experience in large-scale organizing. Indeed, the NLRB rejected the Glaziers' two initial requests for an election at Atari on the grounds that the video-games division contained hundreds more workers than the union had thought. Because the bargaining unit was ruled inappropriate, organizers had not met the minimum legal requirement of signing up 30 percent of those in it. An NLRB election was delayed for many months while the union sought additional support.

In response to the organizing drive, Atari told workers that unions were unnecessary, since the company offered real security, a family atmosphere, and a new approach to labor-management problems. Raymond Kassar, Atari's chief executive officer, sent employees a Christmas message stating that 1982 had been the "best year ever" and that there would be "continued growth, greater business, and more

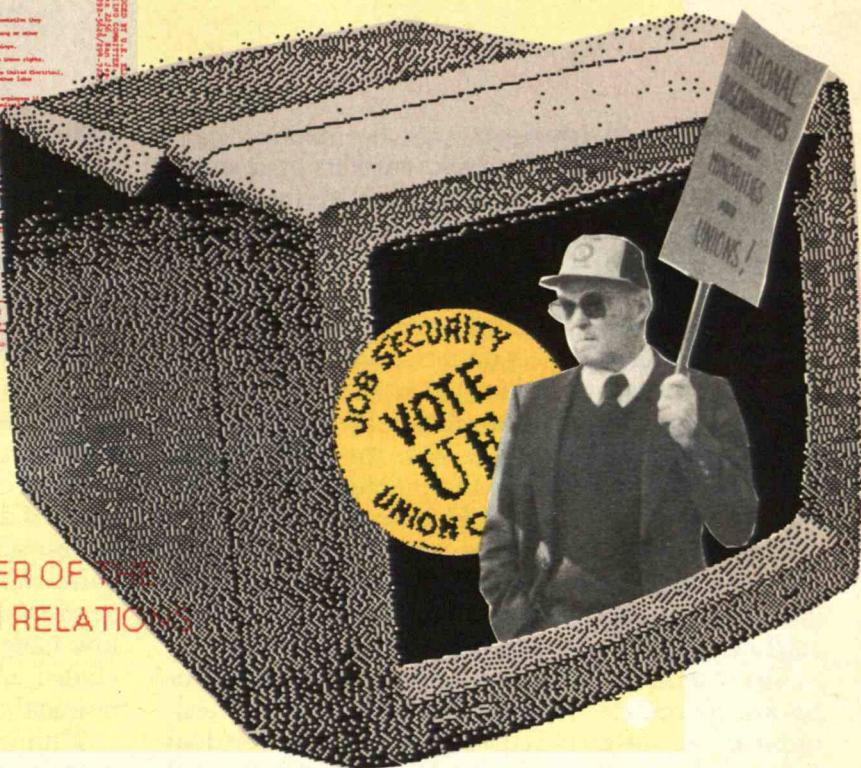
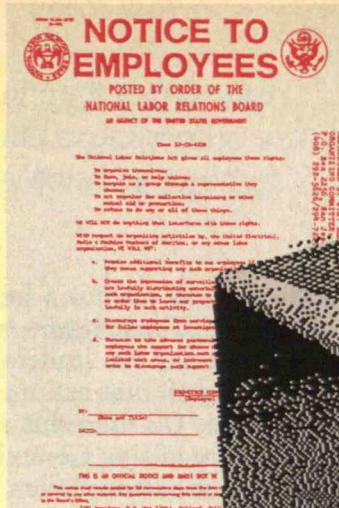
jobs." Eight weeks later Atari fired 500 workers without notice and announced it was moving all its production to Taiwan and Hong Kong, eventually eliminating a total of 2,500 jobs in California.

The Glaziers filed unfair-labor-practice charges with the NLRB, arguing that Atari had ordered the mass layoffs primarily to stop the union. However, the NLRB ruled in favor of the company after Atari presented evidence that it had made plans to shift work to Asia well before the organizing campaign began.

An election was finally held long after most employees had been laid off. Those who remained on the payroll rejected unionization by 143 to 29 votes. In the end, many Atari workers were confused about whether their attempt at unionization was a valid response to their job insecurity or whether it was the reason for the company's decision to relocate its manufacturing operations to Asia.

The question was resolved in an important postscript to the Atari case. The Employment Law Center of the San Francisco Legal Aid Society and the California Plant Closures Project filed a class-action suit on behalf of the laid-off workers. Based on the evidence the company presented to the NLRB to prove it had planned to move even before the union drive began, the lawyers argued that Atari had defrauded the workers of their jobs through deliberate misrepresentation and deceit. The company knew that their jobs were in jeopardy but told the workers otherwise. In June 1986, after years of legal wrangling, Atari settled out of court by paying former employees covered by the suit about \$600,000. The case demonstrates that collective action, supported by professional advocacy groups and unions, can be effective: the back-pay award was the product of both the class-action suit and the original Glaziers NLRB case.

While the Atari battle proceeded, a more carefully planned and well-executed campaign at a high-tech company in Indianapolis also revealed the intensity of employer opposition to unionization. In 1982 several workers from Wavetek, a non-union manufacturer of electronic test and measurement equipment for other high-tech firms, contacted a large CWA local union. The local had a solid record of organizing small telecommunications companies. CWA's national organizing department assisted the local by researching the company's financial situation, investment plans, and ability to shift its production



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to another location.

During an 18-month campaign, Wavetek proved to be a determined and well-financed foe. The company installed huge video screens around the plant to broadcast regular anti-union messages. A management-backed committee of anti-union employees intimidated and harassed pro-union workers. Some of these anti-union workers later became disaffected with Wavetek and detailed their past activities, which had included picketing and vandalizing the union's campaign office.

Supervisors distributed reams of anti-CWA literature, delivered regular anti-union speeches that workers had to attend, held extensive one-on-one meetings with workers, and allowed anti-union committee members to campaign against CWA during company time. Wavetek also instituted more than 25 specific improvements that defused criticism from union supporters. For example, when the union exposed gross wage inequities, the company reduced them. Wavetek also stopped requiring some people to work on their own time to correct problems of quality control. In one particularly hazardous area of the plant, the company automated the process involved and laid off workers.

Three successive layoffs of production workers finally killed the union drive. Because of them, the proportion of workers signing cards calling for an election dropped from a near majority to under 30

percent. In a CWA internal memo, Wavetek organizers wrote, "Each layoff resulted in mass transfers between departments, causing widespread fear and uncertainty. Departments that had a great deal of union support were eliminated. Anti-union workers, on the other hand, were promoted to new classifications to avoid laying them off."

In addition, the layoffs changed the composition of the work force. They caused an increase in the proportion of technicians, who tended to have two-year degrees, white-collar aspirations, and little interest in the union. At the start of the campaign, the ratio of assemblers to technicians was three to one. After the layoffs, the ratio was three to two. The total number of workers, about 1,000 at the start of the campaign, fell to 300. The number is again rising, but the low ratio of assemblers to technicians seems to be permanent. The changes appear not to have greatly diminished Wavetek's business. Its overall sales remained steady, and the plant's output was maintained through rapid automation, subcontracting of work, and extensive overtime.

Regardless of whether the layoffs were intended to fight the union, the result was havoc for workers and CWA organizers. With support for the union fatally eroded, the CWA national office decided to halt the Wavetek campaign. It gradually withdrew its two organizers, leaving only the local CWA union to maintain contact with the fragile rank-and-file

network that still remains.

At both Atari and Wavetek, workers at a single company mobilized in the absence of a larger movement of high-tech workers. As a result, they alone bore the brunt of a concentrated management assault. The AFL-CIO's New England High Tech Organizing Campaign was an attempt to pool union resources, carefully select targets, and coordinate organizing in one geographic area so that separate but simultaneous campaigns would reinforce each other. To this end, five unions—CWA, the International Association of Machinists, the United Autoworkers, the International Union of Electrical Workers, and the Amalgamated Clothing and Textile Workers Union—established and funded a committee of organizers chaired by AFL-CIO regional and national staff members.

The committee hired James Parrott, a labor economist, to produce detailed research on the high-tech industry in Massachusetts and on many individual firms. Based on this research, the committee decided to target organizing efforts at 13 companies near Route 128 north of Boston, in an area where the participating unions already had a substantial concentration of members. The committee retained a professional pollster to determine employee attitudes toward unionization at these firms. The poll, cited at the beginning of this article, revealed widespread anti-union sentiment. But it also showed that 56 percent of workers thought they could acquire clout with their employer only by banding together.

Despite this extensive groundwork, the organizers followed a very traditional course, with each union acting on its own and committing few resources. The outcome was disappointing. A few small group meetings were held, yet not a single full-scale campaign was launched. The participating unions could not engage workers in traditional organizing activity directed toward NLRB elections, and they could not—or would not—develop alternative strategies. By the beginning of 1984, the coordinating committee of organizers no longer even met.

Pre-Union Organizing

The current overwhelming odds against unionization have led to forms of collective activity that do not focus on short-term victories in NLRB elections. Underlying these efforts is the assumption that workers can still organize around such issues as health

and safety as part of a loose "pre-union" network of activists. The struggles can be used to identify and train rank-and-file leaders and demonstrate the effectiveness of joint action.

In 1974, UE used this strategy to build an Electronics Organizing Committee (EOC) at companies throughout Silicon Valley. Unfortunately, for many of its 10 years of active existence, the EOC had only one full-time union staffer, Mike Eisenscher, who frequently had other duties that diverted him from high-tech organizing.

Most of EOC's activity was conducted by a network of dedicated volunteers from some of the area's largest semiconductor manufacturers, such as Intel, Fairchild, Hewlett-Packard, Signetics, and National Semiconductor. The committee operated with a very low budget, but it had an official structure that included elected leaders, formal membership, and nominal dues.

Within individual firms like National Semiconductor, committee supporters were able to lead campaigns for cost-of-living raises, job-security protection, improved health-and-safety conditions, and an end to racial discrimination in job assignments and promotions. At times these efforts even succeeded. For example, in 1979 the UE committee won cost-of-living raises at National Semiconductor, the first across-the-board wage increase in the company's history.

To recruit and serve Filipino and other foreign-born workers, the committee worked closely with community organizations concerned about immigration problems. According to Eisenscher, the need for such collaboration was demonstrated at National Semiconductor. Promising assistance with immigration problems, the company convinced a number of workers to reveal their lack of proper documents. It then gave them 72 hours to provide proof of legal status. Workers who couldn't comply were fired. Thus, the company cut back its work force in a time of declining sales without incurring any liability resulting from unemployment compensation claims. While EOC could give only limited assistance to the workers directly affected, it did counsel other immigrant workers about their legal rights in such a situation.

Because of its own scarce resources, UE gave EOC only limited support. In 1984, UE could no longer afford to keep Eisenscher in Silicon Valley with no immediate prospect of winning union contracts. Eis-

Fifty-six percent of high-tech workers thought they could acquire clout with their employer only by banding together.

Eisenschier took a leave of absence from the union in 1984 rather than be transferred away from Silicon Valley, and he was not replaced.

Meanwhile, management activity had taken a heavy toll. According to Eisenschier, "Much of [EOC's] leadership was fired during the period between 1981 and 1983. The failure of the NLRB to provide any protection compelled some of the most committed leaders to seek work elsewhere, and the operation of an industry 'blacklist' kept some from remaining in the industry at all. They ultimately had to seek jobs outside the industry and, in some cases, outside the Valley."

No pre-union organization has been more persistent in networking within a single firm than the small but feisty IBM Workers United (IBM WU), a nine-year-old committee originating at the computer giant's main manufacturing plant in Endicott, N.Y. IBM has a reputation as an aggressively anti-union company. None of its 242,000 employees in the United States is represented by a union. Even in Western Europe, where unionization is more widespread, IBM union membership is very low. In the past, IBM WU has operated without union assistance and tried to avoid being viewed as a front for organized labor. Recently, however, it signed a mutual-aid agreement with CWA.

IBM WU cooperates with employees in other IBM plants. For instance, it has worked with the IBM Black Workers Alliance, an organization that has pushed the company to increase its commitment to affirmative action in hiring and promotion. IBM WU sent representatives to two international conferences of IBM employee organizations. In the 10,000-worker Endicott plant, it publishes an "underground" newsletter called *The Resistor*. IBM WU activists used to operate secretly, but through *The Resistor* and with the help of community allies it has recently waged ongoing publicity campaigns against favoritism in pay and promotions, unsafe job conditions, dumping of toxic wastes, and the sale of computers to South Africa.

The survival of IBM WU, as well as the increasingly visibility of its leadership, proves that patience, perseverance, courage, and imagination can lead to successful high-tech organizing. But the group's small size and reluctance to be too closely identified with any national union make it a slender reed on which to base large-scale unionization campaigns in the high-tech industry.

The Community-Labor Alternative

High tech now employs over 2.8 million workers, including 1.4 million production workers—more than the steel and auto industries combined. High-tech industries represent 14.4 percent of the total U.S. manufacturing work force and 10.4 percent of all manufacturing production workers.

While non-union high-tech employers are expanding, older manufacturing industries, with their heavily unionized blue-collar work force, are in decline. The U.S. Department of Labor's Bureau of Labor Statistics reports that between 1980 and 1984, 1.5 million unionized manufacturing jobs disappeared. At the same time, more than 600,000 non-union jobs were created, many in high-tech industry.

This trend threatens to further undermine the labor movement. As the percentage of unionized workers falls, unions become correspondingly weaker in their ability to bargain effectively on behalf of their remaining members or organize new members. Unions now represent under 20 percent of eligible American workers, which contributes to their well-publicized setbacks in recent contract negotiations.

To many observers, the 1985 AFL-CIO report, *The Changing Situation of Workers and Their Unions*, signaled a new commitment by the labor movement to develop innovative strategies for the high-tech industry. So far, however, neither traditional nor non-traditional organizing seem likely to receive sufficient backing from any national union. For understandable—yet shortsighted—reasons, most unions prefer to invest only in organizing campaigns that are quicker and easier to win.

As a result, organized labor has abandoned high tech for the time being. Filling this vacuum, as best as it can, is a loose coalition of community, peace, and environmental groups; committees concerned with local occupational safety and health; independent research organizations; labor-education programs; and individual union staff members. In May 1985 many of these groups joined together at a national meeting. Now they operate under the name Integrated Circuit.

Integrated Circuit members are trying to link labor and community concerns about the social and economic impact of high technology. Its organizations are raising issues in more and more regions around the country—from the older centers of high-tech de-
Continued on page 79

The Art of Remedios Varo

A STRUGGLE BETWEEN THE SCIENTIFIC AND THE SACRED

BY PETER ENGEL

THE artist Remedios Varo lived suspended between two worlds. She spent a traumatic life, from 1908 to 1963, struggling to forge the mythic with the scientific, the sacred with the profane. The uneasy alliance between these conflicting worldviews gave tension and strength to her life's work.

The dichotomy began during Varo's childhood in Spain. Her mother was a fervent Catholic who sent Varo to a convent school; her father was an atheist and hydraulic engineer who spoke Esperanto, the new universal language of free thinkers. Her mother taught her to fear the devil, her father to respect reason and draw a proper two-point perspective. As a teenager, Varo fled the convent for an art school in Madrid. She remained on the run, escaping through the Pyrenees to Paris to evade her country's civil war and then fleeing Nazi-occupied France. Only in 1941, when she settled in Mexico, did she find safe haven.

At each stop Varo surrounded herself with intellectuals and soaked up metaphysics and physics in equal parts. When an idea struck her with sufficient intensity, it would stick, and sooner or later, transmuted, it would find its way onto her canvas. Her sources were tenth-century German mysticism, Gregorian chants, medieval alchemy, the novels of Hermann Hesse, the reincarnation theories of G.I. Gurdjieff, and the paintings of Hieronymous Bosch and Pieter

Breughel. She was equally influenced by astronomy, physics, mathematics, engineering, biology, and psychoanalysis.

Varo left a legacy of her travels: over 140 paintings depicting the fantastic journeys of artists and scientists, renegades and refugees, explorers of the *terra incognita* of the mind. Her adventurers travel through forests and fields, above the clouds, along rivers, and down the streets of abandoned cities. They are propelled by the unlikeliest contraptions—jerry-built constructions of pulleys and gears, sprockets and cogs, wheels and wings. These vehicles are scientific in appearance but magical in operation, running on such insubstantial fuel as stardust, music, sunlight, and heavenly ether.

Varo's compositions subtly invert scientific principles, often to comic and unsettling effect. The hirsute detectives in *Capillary Locomotion* transport themselves by rolling their long beards into wheels and grasping their mustaches like handlebars. The *Vagabond* performs an even neater trick, for he is his own vehicle. The overcoat that is driven by propellers and rolls on wheels also houses his pots and pans, a shelf with books, a portrait, a plant, and a house pet.

Such devices evoke a rational world of fantasy, one in which the magical and the supernatural obey their own internal logic, their own rules of cause and effect. In this world of unexpected entrances and unexplained exits, in which characters pass through walls and objects rise into the air of their own accord, in which furniture comes to life and people turn to stone—there is reason, yet.

Many of Varo's works perform an insidious twist on the rules scientists

PETER ENGEL, a writer and designer, is currently a graduate student in architecture at Columbia University. This article is adapted from an essay he wrote for an exhibition of Varo's work by the New York Academy of Sciences. The exhibit is now at the National Academy of Sciences in Washington, D.C.



Remedios Varo



Phenomenon of Anti-Gravity, 1963



Insubmissive Plant
1961

hold sacred. In *Phenomenon of Anti-Gravity*, an astronomer's globe has broken free from its stand and careers toward the open window, drawn by a mysterious object hovering in the night sky. To the alarm of the astronomer, the earth itself has shifted its axis, leaving him suspended with his left foot in one dimension and his right in another. In *Center of the Universe*, Varo playfully reverses the expected relationship between humanity and the cosmos. A man's waistcoat swings wide to reveal stars and galaxies at the very center of the diamond-shaped painting—and of the man's being.

More perplexing still is the botanist in *The Insubmissive Plant*, a man whose hair is made of manifold, minute mathematical equations. While most of his specimens sprout their own equations at the ends of branches and twigs, a single refractory plant grows a flower. The broken stem, weak and withered, lies coiled on the table in the form of the phrase "two and two are almost four." In refusing to be quashed by scientific analysis, Varo's plant sounds the theme for her own rebellion. Varo respected science but rejected it as the only system governing the universe.

A Benevolent Creator

A clue to deciphering Varo's work lies in her affinity with medieval thinking. Her paintings recall the Middle Ages and early Renaissance in subject matter, style, and symbolism. Her settings are defined by heavy Gothic or Romanesque buildings, the architecture of her childhood. The figures who roam her enchanted woods and pace the parapets of her monasteries and castles are the stylized, sometimes caricatured inhabitants of medieval life and legend: magicians in robes, nuns in habits, an itinerant juggler with a face shaped like a pentagram, a medieval symbol of the occult.

In *Embroidering the Terrestrial Mantle*, a group of religious schoolgirls is held captive in a Gothic tower while they weave the fabric of the world. The girl at the far left has embroidered the plan for her own escape: the cloth on her loom shows her fleeing with her secret lover, who can already be seen leaning against the square white house in the lower left part of the canvas. The painting is Varo's mythic retelling of her own flight from the convent set in a medieval context.

But why the Middle Ages? It was perhaps the



Spiral Transit
1962



*Embroidering the
Terrestrial Mantle*
1961

last period in history when the rational and the irrational, the scientific and the spiritual, meshed so thoroughly. This was a time when science was not considered antithetical to religion, when the diversity and plenitude of nature was evidence not of a ruthless struggle for survival but of a great chain of being, set in place by a benevolent creator.

Seen against a medieval backdrop of universal order, Varo's work can be understood as striving to restore to the modern world the harmony that by all appearances it has lost. Although by the time Varo reached Mexico she no longer practiced Catholicism, her early immersion in the religion left a residue of unfulfilled spiritual yearning. Her work evinces a desire for a mystical sense of being to replace the secular sense to which contemporary humans are bound.

The detached, intellectual facade of Varo's work masks a complicated and troubled inner life. In her preoccupation with the conflicts between determinism and free will, between an uncaring universe and a benevolent one, between mortality and perpetual life, Varo pits deeply held tenets of science and religion against each other.

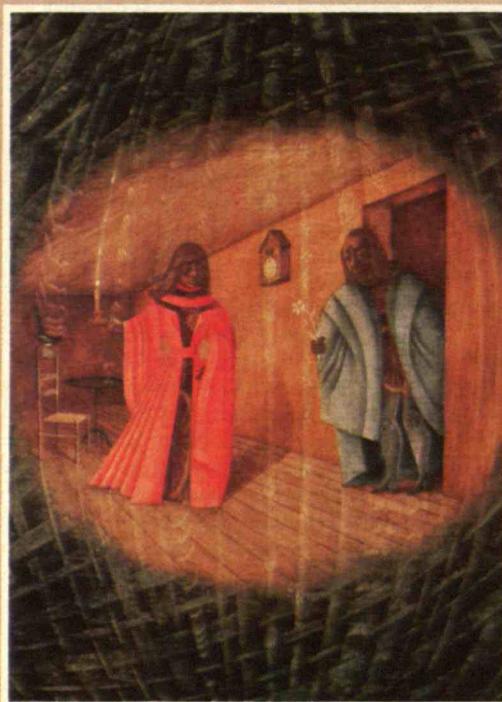
The anthropologist Mircea Eliade calls these

two conflicting tenets the "sacred" and the "profane." In the profane worldview, all of space is uniform, and time progresses forward in a straight line. However, sacred time continually loops back upon itself and creates itself anew. In many religious societies, the new year's ritual is a reenactment of the origin of the world. The sacred view also holds that there are compressed and expanded periods of time and that particular sacred places on earth function at various moments as the center of the world. At a sufficient distance from any of these places, time and space retain their normal properties. But in the places themselves, the sacredness of the world manifests itself through an "hierophany"—the endowment of some ordinary object such as a bird, a pool of water, or a celestial body with religious meaning. The shifting globe in *Phenomenon in Anti-Gravity* and the intruding sphere in *The Revelation or The Clock-maker* are two such examples.

Sacred places occur in many of Varo's paintings. She often created a self-contained, isolated environment by means of architecture and landscape, and then depicted unusual occurrences that subvert the laws of nature. *Spiral Transit* portrays an



The Revelation or The Clock-maker, 1955



Fabric of Space-Time, 1956

entire medieval village in the shape of a spiral, perched serenely on a rock in the midst of a turbulent gray sea. Its symbolism is not hard to decipher. As Eliade writes, the sudden appearance of an island in the middle of the sea, like the emergence of Atlantis, is an archetypal image of creation.

Varo's art also illustrates the changing perception of time and space between the Middle Ages and the present. People in the Middle Ages accepted the notion of sacred time. They believed that time could be reversed and that the origin of the universe could be perpetually recovered. This notion assumed a more mechanistic hue around the fourteenth century: the theologian Nicole d'Oresme compared the world to a gigantic clock that could be started over without apparent loss of energy. Within a couple of centuries, intellectuals all over Europe subscribed to the bishop's potent metaphor, and the astronomer Johannes Kepler could declare, "My aim is to show that the celestial machine is to be likened not to a divine organism but rather to a clockwork." Held together by wheels and cogs, pulleys and springs, Varo's figures embody in microcosm the workings of a mechanistic world. Like the character who inhabits clocks in *The Revelation or The Clock-*

maker, they answer to a higher power.

With the discovery in the mid-nineteenth century of new laws in physics, such a paradisiacal view became untenable. The newly formulated Second Law of Thermodynamics held that heat has a natural tendency to dissipate, a phenomenon also called entropy. As a result of this dissipation, all of matter would eventually disperse and life would terminate in a big, black void. Cyclical time stepped aside for linear time, a one-directional progression from order to chaos, freshness to decay, birth to death. The clock could no longer be turned back.

The Mysticism of a Black Hole

Yet the sacred worldview may still have a place in the new profane order. If, in the profane view, space is an endless Cartesian grid, then the occurrence of an hierophany is a warp in that grid, a distortion of the world's essential homogeneity. It is, to borrow a word from contemporary cosmology, a "singularity." In its technical usage, a singularity is the point at the center of a black hole at which matter is compressed to an infinitesimal size and limitless density. Einstein theorized that a highly concentrated mass distorts the texture of space and time around it. However, such a mass leaves remote objects relatively unaffected because its gravitational pull falls off as the square of the distance. The similarity of this theory to the notion of sacred space is compelling.

Fabric of Space-Time is Varo's meditation on these ideas, a cross-fertilization between ancient myth and modern cosmology. It is an intriguing example of a singularity. In *Fabric of Space-Time*, two medieval figures coalesce out of the criss-crossing threads of the universe. Their bodies are woven from the very warp and woof of the fabric. In the center of the canvas is a vertical line passing through a cuckoo clock, the only straight line in the fabric: the axis of time. The remaining threads trace long, graceful arcs, presumably reflecting the curvature of space.

What is most striking about the painting is its prevailing mood of melancholy. It is an indication of Varo's increasing fear that the world she saw as composed of sacred signs and symbols would turn out to be meaningless, chaotic, profane. What ought to have been a magical moment, a secret and sacred rendezvous, is routine. The two characters are isolated and detached. They have arrived at the same place at the same time, but like most of Varo's figures, they do not interact. The fabric of the universe has brought them together for this strange tryst, and in another moment they will part, perhaps never to meet again. The painting speaks eloquently and sadly of impermanence.

Varo's view of the medieval practice of alchemy



The Useless Science or The Alchemist, 1958

provides another example of the conflict between the sacred and the profane. In *The Useless Science or The Alchemist*, a cloaked figure is engaged in a most precious enterprise, the transmutation of matter. He labors at an edifice of gears, axles, pulleys, siphons, funnels, and retorts, but instead of producing gold from lead, he seems merely to transform water into a mysterious green liquid. The sacred wish of the Middle Ages is shattered; in Varo's contemporary, desacralized view, alchemy is revealed as a hoax. It is a victory for scientific rationalism, but at a price. Destined to turn a crank for eternity in a meaningless act, the alchemist wears an expression of profound disillusionment and despair.

Harmony is another poignant evocation of the search for order in an entropic world. Here all manner of disorder is apparent. Weeds sprout from between the floor tiles, while the peeling walls part to reveal human figures ensconced within. Impervious to the surrounding decay, Varo's protagonist sits placidly at a table, arranging flowers, shells, geometric solids, and mathematical formulas on a musical staff. The contrast between the perfection of the mathematical and musical worlds and the decadence of the material world could not be more pronounced. "This character is trying to encounter the invisible thread that unites all things," Varo wrote, hopefully. But the atmosphere is one of unrelieved sadness.

This unresolved struggle haunted Varo right up to her death. She is described by friends and ac-

quaintances as a woman of great sensitivity and charm—intelligent, well-read, refined, good-natured, but also, by turns, nervous, fearful, morose. At such times she would become intensely introspective, retreating inside her studio, seeing no one. As Varo grew older, her mood swings became extreme. Yet in the detached, philosophical world of her painting from these years, there are hints of a reconciliation of her conflicting material and mythical impulses. Around the late 1950s, she encountered a popular account by astronomer Fred Hoyle on the expanding universe. Varo had always read widely in popular science, counting among her favorite authors Hoyle, the novelist and essayist Aldous Huxley, and the science fiction writers Ray Bradbury, Isaac Asimov, and Robert Heinlein. But Hoyle's book on the universe became one of her favorites.

Steady State vs. Big Bang

The 1940s and 1950s were heady times for cosmology, and Hoyle was often thrust into the center of the debate. The big-bang theory was in vogue, but Hoyle was a renegade. In the steady-state theory, which he expounded, the universe has no beginning and no end. It just is, and as it grows, it generates new matter to fill the gaps. Hoyle's idea had a lot going for it. It matched the observed evidence that the universe is expanding at a constant rate, and it explained why the distribution of mass is everywhere uniform. Conveniently



Harmony, 1956



Still Life Reviving, 1963

enough (but perhaps too conveniently), it pushed aside the thorny question of how the universe began. It also disregarded the Second Law of Thermodynamics, from which the big-bang supporters had drawn the depressing forecast of a world running out of energy, of life doomed to extinction. What Hoyle offered instead was positively euphoric, the promise of perpetual motion, spontaneous generation, and immortality, all rolled up into a legitimate scientific theory. It was almost mythic.

Still Life Reviving, painted shortly after Varo encountered Hoyle's book, is one of her most complex, multi-layered, hieroglyphic images. In Spanish, the title *Naturaleza muerta resucitando* carries a pun that is lost in translation: *naturaleza muerta*, the Spanish equivalent of still life, means literally "dead nature." This dead nature is *resucitando*, coming back to life. The painting itself works on many levels. On a literal level, as an energized depiction of a common domestic scene, it is a sar-

donic comment on the inertness of the typical still life. On a metaphoric level, the painting depicts the entire cosmos, with the revolving fruits as symbols of the planets circling the sun. And on a philosophical level, the image is a powerful affirmation of the concept of reincarnation, of the birth, death, and rebirth of all things. For here, in the real or scientific world, the harmony is not perfect. The fruits, representing planets that have swerved out of orbit (to a medieval mind like Varo's, a sure sign of the apocalypse), have collided and scattered their seeds to the ground.

But from this portent of chaos and destruction comes a cycle of regeneration, the creation of new matter to replace the old: the seeds have taken root and sprouted, and the new plants will bear fruit. The universe can go on. Neither simple harmony nor uncontrolled chaos, *Still Life Reviving* is Varo's boldest and most hopeful statement of a world in mythic

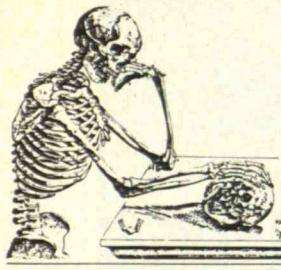
and scientific balance.

Two years after the painting was completed, Arno Penzias and Robert Wilson, astronomers at Bell Laboratories, discovered cosmic background radiation, thought to be a remnant of the original cosmic fireball, and effectively laid the steady-state theory to rest. It would be interesting to speculate about what Varo would have made of this discovery. But *Still Life Reviving* proved to be her last finished work, completed a few months before she died of a massive heart attack.

Strangely enough, following a lifetime of self-portraiture, Varo's final canvas is her only major painting without a human figure. It is as if she saw her life winding down and could keep it going only on a higher plane, transmuted from flesh to spirit, from mass to pure energy. *Still Life Reviving* is thus a self-portrait after all. Varo's presence lingers, like the cosmos background radiation, long after the substance has vanished. □

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Computer Future, Machines from Molecules, and Hyping High Tech

"A Hard" Look at Computers

The Cult of Information
by Theodore Roszak
Pantheon, \$17.95

Reviewed by Mitchel Besnick

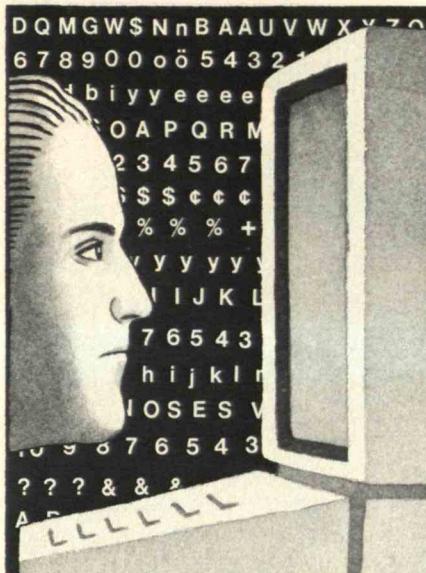
The computer is rapidly becoming one of our most common machines. In 1972 there were fewer than 150,000 computers in the United States. Today there are more than 24 million. If you count the computers built into cars, toys, and appliances, the number is many times higher.

Ironically, this most common of machines is also the most misunderstood. Nowhere are these misunderstandings more evident than in *The Cult of Information*, by California State historian Theodore Roszak. Indeed, the book includes two levels of misconceptions about computers and information. While writing about other people's misconceptions, Roszak reveals many of his own.

In Roszak's view, the expanding role of the computer is part of a centuries-old trend that glorifies numbers and logic at the expense of imagination and creativity. The computer, writes Roszak, is the tool and symbol that Rationalists have been waiting for ever since Descartes—and society is suffering as a result.

Roszak shows how the "cult of information" has affected nearly all aspects of our lives. In politics, for instance, the increasing reliance on polls has deflected "attention from substantive issues by turning debate and electoral judgment into a vacuous statistical game." In military matters, he writes, "War is revised to become the calculation of velocities and trajectories, throw weights and megadeaths." In business, the fascination with the spreadsheet causes problems because "its neat, mathematical facade, its rigorous logic, its profusions of numbers, may blind its user to the unexamined ideas and omissions that govern the calculations."

To make matters worse, computer manufacturers and other "data merchants" spend millions of dollars to convince people that computers can solve almost any problem. The result of this "megahype" is that many people have unreasonable expectations about what today's computers can and should do in homes and schools. This computer mania is altering the way



we view knowledge itself, so that we "drastically undervalue the role of imagination in the creation of ideas, and of ideas in the creation of knowledge, even in the sciences," according to Roszak.

All of this is quite true. So why did I find myself disagreeing with Roszak throughout so much of the book?

Roszak's critique is compelling only as long as he focuses on the way people commonly use computers and information today. He mistakenly leads the reader to believe that computers could not be used in any other way. He assumes that today's uses and (misuses) of computers are inevitable, resulting from the very nature of the machine. Consider these quotes from the book concerning the uses of computers in education:

[The computer] is not teaching students to think in some scientifically sound way; it is persuading them to acquiesce. It is accustoming them to the presence of computers in every walk of life, and thus making them dependent on the machine's supposed necessity and superiority.

But computers need not make students feel inferior. Children who use the Logo programming language to create animations, games, and stories get a feeling of control over the machine. These children use the computer as a tool to express themselves creatively.

Is networking [at a university] really better than gathering of an evening at a nearby

coffeehouse, or pub, or cafe to make conversation?

Of course networking isn't better, but who claims that it is? Networking should be used in addition to, not instead of, other forms of communication. Roszak uses similar reasoning when he attacks the use of the computer as an artistic tool, arguing that children should not be deprived of "real pencil and brush."

[In computer-based simulations] everything always comes out right . . . Simulations are a step away from the disorderly reality around us into the tidy fictions of the computer.

But all abstractions are a step away from reality. Should we reject books since they, too, are a step away from reality? In fact, computers can come closer to simulating "disorderly reality" than any other tool. Roszak never mentions that students can also use computers in "real" scientific experiments by programming them to control motors and receive information from sensors.

Roszak's arguments are similarly flawed when he considers—and strongly rejects—one of the central ideas of artificial intelligence: that thinking is a form of computation. According to Roszak, this idea trivializes the true nature of the human mind. He writes: "We are told that thinking reduces to a matter of shuffling data through a few, simple procedures," and he argues that if thinking is a form of information processing, then this leads to the idea that "more data will produce better understanding."

In my mind, the problem is quite the reverse. Roszak's arguments trivialize the true nature of information-processing systems. Computer programs are certainly not limited to a "few, simple formal procedures." What if the computer were programmed to perform trillions of formal procedures? And what if these procedures interacted in complex ways?

This type of computer program would be very different from today's programs. The interactions among the trillions of low-level procedures could lead to unexpected "higher-level" behavior. Irrational or creative behavior could emerge from a foundation of formal rules, just as our own behavior emerges out of the trillions of low-level rules that govern the workings of our brains.

Atom-scale construction
is not just possible but inevitable in the
foreseeable future.

The idea that creativity can emerge from formal rules might seem paradoxical. But that is the power of complexity. The situation is somewhat similar to the relationship between atoms and everyday objects. Every atom consists primarily of empty space, yet a chair, consisting of trillions and trillions of atoms, seems solid and impenetrable. With computers, the emergent high-level properties could be even more unpredictable.

In this view, favored by "connectionists," computers take on a new image. At one level, computers are "hard" (logical and predictable). But on another level, they can be "soft" (flexible and creative). Whether we will ever build computers and programs that achieve this kind of behavior is an open question. But the potential is there.

Roszak is right that people overvalue numbers and logic, and they will continue to do so as long as they focus on the hard side of computers. What we need is a more general conception of computers that combines the hard and the soft. As people accept this new conception, they will recognize that numbers and logic are not necessarily the best level of description for understanding computers—or themselves.

How quickly will people adopt this new view of minds and machines? A century after Darwin, we are still haunted by creationists, so I have no doubt that the intellectual descendants of Roszak will continue to attack the information-processing model of mind a century from now. But the change has begun. Eventually, people will realize that computers can be both "hard" and "soft" at once.

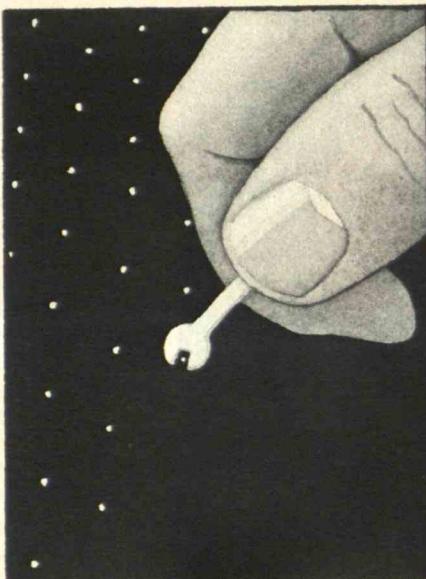
MITCHEL RESNICK, a former journalist, is a graduate student in computer science at M.I.T.

Machines from Molecules

Engines of Creation
by K. Eric Drexler
Doubleday/Anchor Press, 17.95

Reviewed by Hans Moravec

Living organisms are clearly machines when viewed at the molecular level. Information encoded in RNA directs protein-assembly devices called ribosomes to pluck sequences of amino acids from their



environment and attach them to the ends of growing chains. Depending on their sequence, the proteins then fold up in various ways to do their jobs. Some have moving parts that act like hinges, springs, latches, or pistons. Others are primarily structural, functioning like bricks, ropes, or wires. Visionaries in semiconductor and biotechnology labs are pursuing the possibility of using genetic engineering to create miniature machines based on these properties—machines that themselves could be used to build almost anything.

In *Engines of Creation*, K. Eric Drexler describes how the technology of atomic-scale construction might work and the astounding implications for human life. The first generation of artificial molecular machinery, made of protein, would be engineered to do specific jobs using mechanisms recruited from living cells. Early products would be simple, such as tiny computer circuits and molecular mousetraps designed to capture viruses. Gradually a collection of components and computer design aids would accumulate for building more complicated machines.

Eventually it would become possible to build tiny robot arms, and equally tiny computers to control them, able to grab molecules and hold them, thermally wriggling, in place. This apparatus could then be used as machine tools to build a second generation of molecular devices. For instance, carbon atoms might be laid, brick-like, to form ultra-strong fibers of perfect diamond. General-purpose microscopic

assemblers would be able to analyze and construct nearly anything, atomic layer by layer.

Drexler calls this enthralling scheme nanotechnology, for the nanometer (billionth-of-a-meter) scale of its parts. By contrast, today's integrated-circuit technology has features a thousand times bigger. Nanotechnology takes advantage of the fact that atoms are perfectly uniform in size and shape and behave predictably, unlike the nicked, warped, and cracked parts in larger machinery. Many of the details that Drexler presents are sitting ducks for skeptics' potshots, but I find his central point convincing: that atomic-scale construction is not just possible but inevitable in the foreseeable future.

The human benefits from this technology will be without limit. Self-replicating machinery will be able to create a mind-boggling abundance for all. Trillions of intelligent robots, each thousands of times smaller than a cell, will repair humans from the inside, molecule by molecule. Immortality will become possible. Humanity will not only be able to use the technology to colonize space but will want to do so to make room for all the wealth created.

Drexler does fear a "gray-goo" scenario in which rogue replicators escape human control and sweep the world in a life-destroying plague. The defenses of natural life would be no match for the much smaller, tougher, faster, and smarter artificial beings. Drexler proposes that humanity develop a standing army of tame nanomachines that would function as a hyper-sophisticated immune system to defend against such outbreaks of nano wildlife. I have an image of molecular gestapo agents checking identity papers and summarily executing suspicious characters. Drexler wants to keep the "good" machines in that state by making their hardware and software massively redundant to prevent spontaneous mutations.

But his proposals for maintaining this unnatural status quo are unconvincing and absurdly anthropocentric. Why should machines millions of times more intelligent, fecund, and industrious than ourselves exist only to support our ponderous, antique bodies and dim-witted minds in luxury? Drexler does not hint at the potential lost by keeping our creations so totally enslaved. Moreover, his solution would put the defenders at a disadvantage against fleet-footed, rapidly evolving guerrilla nanolife unencumbered by bureau-

cratic baggage. Genius gray goo might infiltrate the guards with its own agents and gradually subvert the defense from inside, for example. Rogues could also escape beyond the frontier of controlled space and mass for a frontal assault.

Drexler squirms hard to avoid the conclusion that intelligent nanolife will, by sheer merit, displace natural life. Liberated, it could carry the human enterprise in unimaginable directions and distances. Is this evil? If you view conventional humanity as the end of creation, then yes. If instead you see a universe full of untapped potential, then this technology will be a wonderful development. The smarter children of our minds will fulfill our hopes and dreams, dwarfed by their own enormously larger ponderings.

Want to go along? Ask medical nanobes to rebuild you from the inside out in their own image. Want to stay? Perhaps the new organisms will maintain an archeological museum in which to accommodate you. Life there may be very much like the uto-pia the book promises, gently guided by nanolife curators.

Drexler estimated that the time to these developments is under 50 years. I concur. Our accelerating technology will soon reach a kind of escape velocity that will carry us into a new and radically different world.

HANS MORAVEC is senior research scientist at The Robotics Institute at Carnegie-Mellon University.

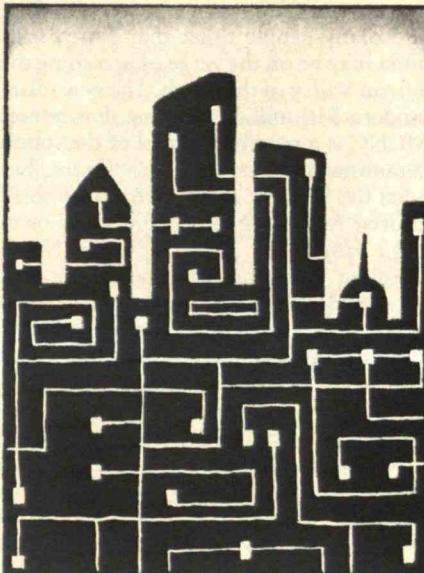
Hyping High Tech

High Hopes for High Tech
edited by Dale Whittington
University of North Carolina Press, \$36

Reviewed by Tobi Lippin

Everyone's jumping on the high-technology bandwagon, the rage in industrial recruitment. Visions of high-paying jobs for the un- and underemployed and clean and modern factories dance in the minds of local, state, and federal officials in the United States and abroad, all of whom want to write their tickets to successful economic development.

However, as with much in today's world of public-relations hype, a closer look reveals a different story. In *High Hopes for High Tech*, Dale Whittington



and 14 other authors attempt to look behind the glitter of microelectronics policy in North Carolina, the scene of much recruitment of high-tech business.

Led by former Governor James B. Hunt, the state launched an intensive effort to convince microelectronics companies to locate there. Fueled by the prospect that General Electric would do so, Hunt skillfully secured \$1 million of the state's contingency and emergency funds to start the Microelectronics Center of North Carolina (MCNC) in June 1980. MCNC was designed to do state-of-the-art R&D and train students in microelectronics technology and its uses. Hunt and his supporters were counting on MCNC and the state's low unionization rates, wages, and taxes, all of which were touted by recruiters, to make the difference. And in August of 1980, GE announced that it had decided to locate its new facility in North Carolina, citing MCNC as a key factor.

In January 1981 state legislators faced a \$24.4 million appropriation for MCNC in the governor's budget, despite a tight fiscal situation and budget slashing in almost all other areas. Hunt argued that the state could not turn back now. Community, environmental, and occupational-health groups urged the state to set aside a portion of the funds to study the effects of the highly toxic chemicals used by the industry, but the appropriation passed without a public hearing and without these provisions.

These recruitment efforts have drawn



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extensive attention in the national media, and many people think that North Carolina may be on the verge of becoming the Silicon Valley of the South. The new ultra-modern \$10 million building that houses MCNC is a tangible symbol of the state's commitment to its high-tech future. But what has been the actual outcome of these efforts? According to Gregory Sampson in *High Hopes for High Tech*, the North Carolina semiconductor industry is still very small. "In 1982," he writes, "There were only six such firms located in North Carolina, and each employed fewer than 100 workers. Through 1984, there were five semiconductor electronics firms, employing between 300 and 400 workers."

Moreover, most of the jobs have been created in the already booming Research Triangle (Raleigh/Durham/Chapel Hill) area, while double-digit unemployment remains a problem in the state's coastal and mountain regions. Housing costs are also rising and congestion problems are

getting worse in the Raleigh/Durham area—unanticipated effects that will require further expenditures by local communities.

Nor is the electronics industry a high-wage sector. In 1982, N.C. high-tech workers earned slightly less than the average hourly wage for all the state's manufacturing workers, and placed eleventh among the 20 major manufacturing groups. That same year GE revealed that its starting pay for production workers would be around \$5 per hour, below even the average textile wage of \$5.62. The high-tech work force is also largely segregated by race and sex, with most production jobs filled by women and minorities. These results led the *Raleigh News and Observer* to query, "Will the state's quest for high-technology industry produce an economic boom or merely the 1980s' version of the cotton mill?"

Michael Luger provides the best analysis of these outcomes in the book. He concludes that the state's goals of higher wages, more jobs, greater job stability, and geographically balanced development will not be met without some changes in current policy. Luger suggests that the state will reap yields commensurate to its investment in high tech only if it reexamines its anti-union stance.

Only one author in this volume addresses the problem of toxic substances in the industry. Noticeably absent is any discussion of the exposures that production workers routinely undergo. High-tech workers operate in "clean rooms" with elaborate ventilation systems that constantly regulate temperature and dust levels. However, these precautions are designed to protect the chips, not the workers. The rates of occupational illness in the state's high-tech industry are more than three times those for manufacturing as a whole, according to the N.C. Department of Labor. The authors also fail to address the problem of contamination of water supplies that has plagued Silicon Valley and may threaten North Carolina's traditionally clean aquifers.

What the push to bring high tech to North Carolina will ultimately bring remains to be seen, but this shortsighted approach may in the long run shatter the high hopes being championed today.



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TOBI LIPPIN is coordinator of the North Carolina Occupational Safety and Health Project in Durham.

development in Massachusetts and California to the newer ones, such as North Carolina's Research Triangle, Texas's Silicon Prairie, Colorado's Silicon Mountain, Oregon's Silicon Forest, and Michigan's Automation Alley. The North Carolina Occupational Safety and Health Project (NCOSH) has produced *Microelectronics Safety and Health in the Workplace*, a handbook that details what workers can do if they face particular hazards. In cooperation with the CWA Women's Network, NCOSH has also conducted a ground-breaking study of health problems faced by VDT operators. Finally, the group handles unorganized workers' requests for information and assistance. In response to the handbook and a reference in a *Ms.* magazine article, it received calls from high-tech employees in Research Triangle Park. NCOSH provided these workers with information about health problems and employee rights, and connected them with unions that could help further.

However, Integrated Circuit's activities cannot match the effectiveness of true labor unions. Its activists argue that unions should begin providing assistance in several crucial areas. Former UE organizer Eisenscher has developed a proposal that outlines how these functions could be performed once again in Silicon Valley. He proposes an electronics workers' organizing and service center that unions could launch with only modest funding.

Finally, high-tech firms increasingly oppose state and national legislation to protect workers. This legislation deals with such issues as plant closings, the right to know, VDT-hazard protection, workers' compensation, and unemployment benefits. In their lobbying, industry representatives invariably purport to speak for everyone in high tech—owners, managers, and workers. The industry's economic and political outlook is strongly reflected in the Republican Party and growing neo-liberal wing of the Democratic Party, which increasingly criticizes and repudiates organized labor as the legitimate voice of workers. The labor movement's viability as an effective champion of the interests of all workers requires it to challenge the industry's political agenda.

If the labor movement fails to undertake new initiatives, it does so at its own peril. The future in high tech will most certainly be as union-free—and the workers within it will remain as vulnerable—as they are today. □

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Chasing Arthritis

The hip-replacement surgery performed in 1984 on 73-year-old Helen Flint was unique among the 50,000 such operations performed annually. The artificial bone implanted in Flint by orthopedic surgeons at the Massachusetts General Hospital is equipped with 14 tiny strain gauges to measure the pressures exerted on the joint in daily use. It also contains a tiny telemetry device to broadcast results to the outside world.

Flint regained normal mobility within six months after surgery. Since then she has visited M.I.T. monthly for tests of the pressure on her hip joint during activities ranging from sitting to jogging.

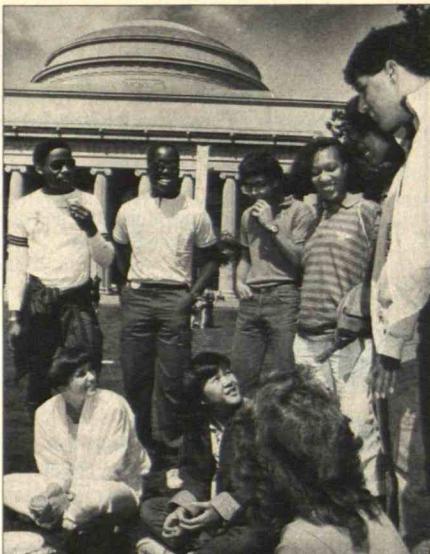
The device was designed at the M.I.T. Biomechanics and Human Rehabilitation Laboratory under the direction of Robert W. Mann. It has now provided researchers with vastly increased understanding of the structure and function of the hip joint, including a few surprises.

For example, the data show that the pressure on the cartilage—the smooth surface material that coats the hip joint—is neither uniform nor symmetrical as originally thought. Rather, it is highly irregular. It carries up to three times body weight during slow walking, and during vigorous activity, it may carry ten times that. This translates into a maximum of almost 3,000 pounds per square inch of tissue area.

The researchers conclude that such forces leave only a small margin for error: slight changes in the distribution of the maximum forces could lead to tissue breakdown and osteoarthritis. Furthermore, wherever pressure is highest, the cartilage layer thins. Osteoarthritis may be most likely to develop in these areas. Mann thinks Flint's surgery is an important start toward understanding that might lead to the prevention of arthritis.—Heather Irving

Shear Hazard

Commercial aircraft arrivals and departures during thunderstorms are "at least 400 times more dangerous" than those during normal weather, according to an analysis by Arnold Barnett of the Sloan School of Management. Indeed, "landing or taking off during a thunderstorm is by far the most hazardous activity to which domestic passengers are exposed," says



Nearly 40 percent of M.I.T.'s freshmen are women—a new record, up a stunning 10 percent in one year. The class also includes 30 percent minorities—Native Americans and American Blacks, Hispanics, and Asians. In all, 6,212 students applied for just under 1,000 places.

Barnett, who teaches operations research.

Hence his argument that U.S. commercial airports should be closed whenever thunderstorm cells approach within five miles of their control towers.

The hazard is wind shear, a condition that begins with what meteorologists call a "microburst," a blast of cold air that descends with the rain in a thunderstorm cell. Striking the ground, this cold air "splashes" out from the center. Its initial velocity may be 20 to 25 knots, but within five minutes it can intensify to as high as 100 knots. An aircraft flying into a microburst experiences very rapid changes in wind—head wind to down draft to tail wind, for example. Such a scenario is "very, very capable of causing bad problems," says John McCarthy of the National Center for Atmospheric Research (NCAR) in Boulder, Colo. It's like suddenly losing 100 knots of speed at an altitude of 500 feet, McCarthy reports after a major NCAR project at Denver's Stapleton Airport.

Three federal agencies—the Federal Aviation Administration, Department of Commerce, and Department of Defense—are working on NEXRAD, a doppler radar system to warn control-tower personnel of

wind-shear conditions. It won't be ready to deploy at even a few major airports until 1989. General use is likely by the mid-1990s.

Until then, says Barnett, closing airports for thunderstorms is both good sense and good economics. Thunderstorms occur on average only 25 hours a year in typical American cities, so the inconvenience would be minimal. And the cost would surely be less than the value of the aircraft and the lives of the people aboard that are at risk. At least three U.S. crashes causing over 400 deaths were attributed to wind shear between 1975 and 1985.

Strongest Magnet

The record for the world's most powerful magnetic field moved from Japan to M.I.T. early this summer. Lawrence G. Rubin and his colleagues at the Francis Bitter National Magnet Laboratory produced a field of 33.6 tesla, about 700,000 times more powerful than the earth's magnetic field. The previous record of 30.7 tesla was reached early this year at the Institute for Iron, Steel, and Other Materials in Sendai, Japan.

The National Science Foundation, which supports the M.I.T. work, says research on high magnetic fields is important because electrons in such fields become more spatially confined, behaving like a liquid instead of a gas. Thus, for example, the electrons flow through conductors more easily—an important advantage in creating new semiconductors and superconductors for communications, computers, and energy converters.

Earning High Pay

The idea that high pay is an automatic result of long employment is too simple, say Katharine G. Abraham and Henry S. Farber, who analyzed data collected by the University of Michigan Survey Research Center. What really happens is that workers who are well matched to their jobs tend to hold them longer. The workers are rewarded not for length of service but for quality of performance. Workers with short job histories earn less because they are likely to fit their jobs less well.

Abraham and Farber say their findings prove incorrect the hypothesis that companies pay young people low salaries and older people high salaries as an incentive for long-term service.



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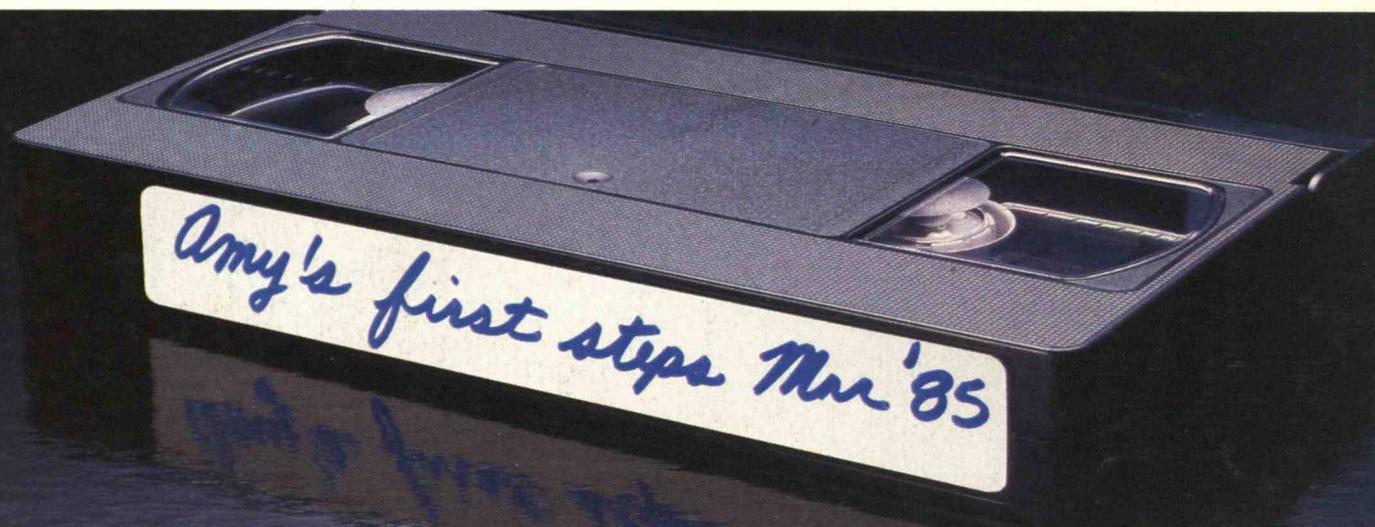
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